THE REVIEW OF APPLIED ENTOMOLOGY

SERIES B : MEDICAL AND VETERINARY

VOL. 41
(1953)

ISSUED BY THE COMMONWEALTH INSTITUTE OF ENTOMOLOGY

LONDON:
COMMONWEALTH INSTITUTE OF ENTOMOLOGY,
56 QUEEN'S GATE, S.W.7
1955

All Rights Reserved

Commonwealth Agricultural Bureaux

EXECUTIVE COUNCIL.

J. E. C. COVENTRY, B.A., M.Sc., *Chairman*, Federation of Rhodesia and Nyasaland.

A. I. PERERA, C.B.E., *Vice-Chairman*, Ceylon.

W. C. TAME, United Kingdom.

J. G. MALLOCH, M.B.E., *Acting*, Canada.

W. IVES, M.Ec., Australia.

V. ARMSTRONG, B.Sc., Ph.D., D.I.C., New Zealand.

E. D. ANDREWS, *Acting*, Union of South Africa.

H.E. the High Commissioner for India, India.

Vacant, Pakistan.

C. E. LAMBERT, C.M.G., Colonial Territories.

Sir HERBERT HOWARD, *Secretary*, Farnham House, Farnham Royal, Nr. Slough, Bucks.

COMMONWEALTH INSTITUTE OF ENTOMOLOGY

Director and Editor.
W. J. HALL, C.M.G., M.C., D.Sc.

Assistant Director.
E. O. PEARSON, B.A.

Assistant Editor.
H. S. BUSHELL, M.A.

Head Office—c/o British Museum (Natural History), Cromwell Road, London, S.W.7.

Publication Office and Library—56, Queen's Gate, London, S.W.7.

ERRATA

Page 39 8 lines from end for " given " read " give "

,, 111 line 15 for " Oudm." read " (Oudm.) "

,, 111 11 lines from end for " *Potomonautes* " read " *Potamonautes* "

,, 122 line 32 for " of DDT " read " to DDT "

,, 124 10 lines from end for " *domestic* " read " *domestica* "

,, 143 lines 26, 28, 31, 40 and 44 for " Arochlor " read " Aroclor "

,, 191 line 15 for " *A. cruzi* " read " *A. cruzii* "

,, 213 line 9 for " (R. A.) " read " (Sir R. A.) "

COMMONWEALTH INSTITUTE OF ENTOMOLOGY.

REVIEW

OF

APPLIED ENTOMOLOGY.

SERIES B.

Vol. 41. 1953.

EDITORIAL

THE NOMENCLATURE OF CHEMICALS USED FOR PEST CONTROL

During recent years, committees have been set up in the United States and the British Commonwealth to devise and define simple "common" names for the complex organic chemicals used for the control of pests, particularly arthropods, fungi and weeds. They include the Pest Control Products Industry Standards Committee in Britain, the Canadian Committee on Common Names of Insecticidal and Fungicidal Chemicals, the U.S. Interdepartmental Committee on Pest Control, and the Committee on Insecticide Terminology of the American Association of Economic Entomologists. These committees have worked in liaison, and two lists of names approved by one or more of them have been published, one as British Standard 1831 : Part 1 : 1952, and the other in the *Journal of Economic Entomology* **45** (1952) pp. 165–166.

The names that have been recommended for insecticides are being increasingly used, without further chemical definition, by authors of papers on insect control, and it is proposed to use them in the same way in future abstracts in this *Review*, though the chemical name may also be included if the nature of the paper abstracted makes it particularly desirable. To facilitate their subsequent identification by readers, the names to be adopted are tabulated below in alphabetical order.

The recommended common name of each compound is shown in the first column of the table, the chemical name or names in the second, and other names that have been used in the third. Names marked by "a" are recommended by the Committee of the American Association of Economic Entomologists, names marked by "b" are adopted in the British Standard 1831, and names marked by "c" have been adopted by the U.S. Interdepartmental Committee. DDD, and bromo-, fluoro-, methoxy- and methyl-DDT are names adopted for DDT analogues in this *Review*, and the last four are designed to provide a consistent nomenclature for analogues of comparable structure. They are names indicative of structure in the same way as is the recommended methyl-parathion.

If additions to the list or changes in it become desirable, these will be given at the beginning of the annual volumes of the *Review*.

(42) Wt. P0/3870 2/53 S.E.R. Ltd. Gp. 432. [B]

Recommended common names	Chemical names or definitions	Other names
aldrin[a,c]	not less than 95 per cent. of 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene	compound 118
allethrin[a,c] ...	*dl* - 2-allyl - 4 -hydroxy-3-methyl-2-cyclopenten-1-one esterified with a mixture of cis and trans *dl*-chrysanthemum monocarboxylic acids	allyl homologue of cinerin I synthetic pyrethrins
BHC[a,b]	1,2,3,4,5,6-hexachlorocyclohexane benzene hexachloride (BHC is used for a mixture of isomers ; the British Standard requires that the percentage of γ BHC be stated, whereas the American definition applies BHC to a mixture containing 12–14 per cent. γ BHC.)	HCH 666
α BHC, β BHC, γ BHC, etc.	individual isomers of the above	
bromo-DDT ...	a complex chemical mixture in which p,p′bromo-DDT [*q.v.*] predominates	
p,p′bromo-DDT ...	1,1,1-trichloro-2,2-di(p-bromophenyl)ethane	
chlordane[a,b,c] ...	2,3,4,5,6,7,10,10 - octachloro - 4,7,8,9 - tetra - hydro-4,7-endomethyleneindan 1,2,4,5,6,7,8,8 - octachloro - 3a,4,7,7a - tetra - hydro-4,7-endomethanoindan 1,2,4,5,6,7,8,8 - octachloro - 2,3,3a,4,7,7a - hexahydro-4,7-methanoindene	chlordan
DDD	a complex chemical mixture (*e.g.*, commercially available dichlorodiphenyl-dichloroethane) in which p,p′DDD [*q.v.*] predominates	TDE[a]
p,p′DDD	1,1-dichloro-2,2-di(p-chlorophenyl)ethane	
DDT[a,b]	a complex chemical mixture (*e.g.*, commercially available dichlorodiphenyl-trichloroethane) in which p,p′DDT [*q.v.*] predominates (The British Standard requires the percentage of p,p′DDT to be stated.)	dicophane, B.P. (75 per cent. p,p′DDT) chlorophenothane, U.S.P. (14 : 136. 1950)
p,p′DDT	1,1,1 -trichloro -2,2 -di(p -chlorophenyl)ethane	
dieldrin[a,c] ...	not less than 85 per cent. of 1,2,3,4,10,10-hexachloro - 6,7 - epoxy - 1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimethanonaphthalene	compound 497
dimethyl carbate[a] ...	dimethyl ester of cis-bicyclo(2.2.1)-5-heptene-2,3-dicarboxylic acid	
dinex[b]	2-cyclohexyl-4,6-dinitrophenol 2,4-dinitro-6-cyclohexylphenol 4,6-dinitro-o-cyclohexylphenol Salts or esters of this compound are to be differentiated by the addition in brackets of the name of the combining substance, *e.g.*, dinex (sodium).	DNOCHP
dinosam[b]	2-(1-methyl-n-butyl)-4,6-dinitrophenol 2,4-dinitro-6-sec.-amylphenol 4,6-dinitro-o-sec.-amylphenol Salts or esters to be cited as indicated under dinex.	DNAP DNSAP DNOSAP

Recommended common names	Chemical names or definitions	Other names
dinoseb[b]	2-(1-methyl-n-propyl)-4,6-dinitrophenol 2,4-dinitro-6-sec.-butylphenol 4,6-dinitro-o-sec.-butylphenol Salts or esters to be cited as indicated under dinex.	DNBP DNSBP DNOSBP
DNC[b]	2-methyl-4,6-dinitrophenol 2,4-dinitro-6-methylphenol 3,5-dinitro-o-cresol [numbered with CH_3 as 1] 4,6-dinitro-o-cresol [numbered with OH as 1] Salts or esters to be cited as indicated under dinex.	DNOC dinitrocresol
fluoro-DDT ...	a complex chemical mixture in which p,p'fluoro-DDT [*q.v.*] predominates	
p,p'fluoro-DDT ...	1,1,1-trichloro-2,2-di(p-fluorophenyl)ethane	DFDT[a]
heptachlor[a,b,c] ...	1(or 9),4,5,6,7,10,10 - heptachloro - 4,7,8,9 - tetrahydro-4,7-endomethyleneindene 1(or 3a),4,5,6,7,8,8 - heptachloro - 3a,4,7,7a - tetrahydro-4,7-endomethanoindene 1(or 3a),4,5,6,7,8,8-heptachloro - 3a,4,7,7a - tetrahydro-4,7-methanoindene 3,4,5,6,7,8,8a-heptachlorodicyclopentadiene	
lindane[a,c]	γ isomer of BHC [*q.v.*] of not less than 99 per cent. purity	
malathon[a,c] ...	O,O-dimethyl dithiophosphate of diethyl mercaptosucc nate S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate	compound 4049
methoxy-DDT ...	a complex chemical mixture in which p,p'methoxy-DDT [*q.v.*] predominates	dianisyl trichloroethane
p,p'methoxy-DDT	1,1,1-trichloro-2,2-di(p-methoxyphenyl)ethane	methoxychlor[a,c]
methyl-DDT ...	a complex chemical mixture in which p,p'methyl-DDT [*q.v.*] predominates	ditolyl trichloroethane
p,p'methyl-DDT ...	1,1,1-trichloro-2,2-di(p-methylphenyl)ethane	
methyl-parathion[a]	O,O-dimethyl O-p-nitrophenyl thiophosphate	methyl homologue of parathion
paraoxon[a]	diethyl p-nitrophenyl phosphate	oxygen analogue of parathion E-600
parathion[a,b,c] ...	O,O-diethyl O-p-nitrophenyl thionphosphate O,O-diethyl O-p-nitrophenyl thiophosphate	E-605
piperonyl butoxide[a]	product containing as its principal constituent α-[2-(2-butoxyethoxy)-ethoxy]-4,5-methylenedioxy-2-propyltoluene	
piperonyl cyclonene[a]	mixture of 3-alkyl-6-carbethoxy-5(3,4-methylenedioxyphenyl)-2-cyclohexen-1-one and 3-alkyl-5(3,4-methylenedioxyphenyl)-2-cyclohexen-1-one.	
schradan[a,b] ...	bisdimethylaminophosphonous anhydride bis(bis(dimethylamino))phosphonous anhydride octamethyl pyrophosphoramide tetra(dimethylamido)pyrophosphate	OMPA
toxaphene[a,b,c] ...	chlorinated camphene having a chlorine content of 67–69 per cent.	compound 3956

KRISHNAN (K. V.) & others. **The Breeding and Maintenance of *Trombicula deliensis* in the Laboratory for experimental Purposes.**—*Indian med. Gaz.* **84** no. 2 pp. 39–41, 1 pl., 2 refs. Calcutta, 1949.

In recent years, it has been found that endemic foci of tsutsugamushi disease (XK typhus) are widespread in the East [*cf. R.A.E.*, B **37** 224; **38** 192; **39** 105]. Bengal, where the disease was not known to occur, has many foci, some in the immediate neighbourhood of Calcutta. Investigations in these foci showed that rats were infected with *Rickettsia orientalis* and heavily infested with *Trombicula deliensis* Walch, the suspected vector. To investigate whether *T. deliensis* transmitted the disease locally, it was necessary to breed it in captivity. This had not previously been accomplished, but was done by using mosquito eggs as food for the nymphs and adults [*cf.* **37** 112]. Infested rats were collected in the summer of 1948 and caged over a dish of water into which the engorged larvae were allowed to fall. They were collected from it and transferred to tubes containing a layer of moist sterilised sand and closed with well-fitting corks covered with cotton cloth. They passed within two days into the nymphochrysalis stage, which lasted 7–8 days. When nymphs emerged, broken-up *Culex* egg rafts were supplied. The nymphal and second resting (or imagochrysalis) stages lasted 7–14 and 7 days, respectively. It was found advantageous to make grooves in the sand to provide shelter for the mites. Adequate moisture was essential, but the control of fungi, which killed the mites by smothering them or interfering with their movements, was a difficulty. The adults deposited eggs indiscriminately, a few at a time, over a period of about five months. The egg and deutovum stages each lasted 7 days. The devices used for preventing the escape of infected larvae and the technique of feeding larvae on mice are described. The colony of mites started in June 1948 was in the third generation in December. The various stages are briefly described.

KRISHNAN (K. V.) & others. **Transmission of *Rickettsia orientalis* by the Bite of the Larvae of *Trombicula deliensis*.**—*Indian med. Gaz.* **84** no. 2 pp. 41–43. Calcutta, 1949.

Details are given of experiments to determine whether *Trombicula deliensis* Walch is the vector of *Rickettsia orientalis* in the Barrackpore area of Bengal [see next abstract]. Transmission was effected in five out of eight experiments. Larval mites were obtained from rats in the Barrackpore area, and first-generation progeny reared from them [*cf.* preceding abstract] were fed on infected mice. Larvae of the second generation were used in transmission experiments. The eight mice on which these larvae were fed were killed as soon as they showed signs of illness, or after 30 days if they did not. They were then examined for rickettsiae in peritoneal scrapings, and emulsions of their brains were inoculated intraperitoneally into fresh mice. The procedure was repeated with the passage mice. No rickettsiae were found in any of the eight mice on which the mites were fed, but the infection of five was demonstrated by the finding of rickettsiae in the next passage mice. The five infected mice looked ill when they were killed, though none appeared likely to die of the disease. In nature, the infection in rodents seems to be inapparent. Strains of rickettsiae identical with strains from human cases of tsutsugamushi disease (XK typhus) have been isolated from the brains of apparently healthy wild rats. So far, natural rickettsial infection has not been found by the authors in the breed of mice used in the experiments.

KRISHNAN (K. V.) & others. **Epidemiological Observations on XK or Mite-borne Typhus in Barrackpore, Bengal.**—*Indian med. Gaz.* **84** no. 2 pp. 63–68, 3 graphs, 12 refs. Calcutta, 1949.

An account is given of observations made and conclusions reached in investigations on XK typhus (tsutsugamushi disease) in Barrackpore, a cantonment

town about 14 miles north of Calcutta. Available information on the epidemiology of the disease in other areas is reviewed. There are no records to show that typhus fevers were prevalent in Bengal before 1940, but many cases of all three serological types (XK, X19 and X2) were reported from various places there during 1940–46. In the autumn of 1946, an unusual increase in fever cases occurred among the civil population of Barrackpore, and about 20 per cent. of the cases admitted into hospitals during October and November were typhus of one kind or another, with XK predominating. Cases of typhus continued to occur regularly throughout the year, with the maximum incidence between May and October. Medical records showed that sporadic cases had been occurring since 1905 among troops in the area, that the number of cases rose with the stationing of more troops during the second world war, that cases were most numerous in troops stationed in fields and on previously unoccupied land, and that the incidence and severity among civilians increased greatly after the stationing of larger numbers of troops in the area. Examination of over 500 fever cases between 1946 and 1948 by the author showed that typhus fevers of the three types were occurring in the civilian population, with XK predominating. Of the XK cases, 80 per cent. are mild and 20 per cent. severe. Mild cases were mostly in local people and severe ones in new-comers, and most cases occurred in adult males working or camping in scrub jungle. The evidence indicates that Barrackpore is an old endemic area.

Of 1,064 small mammals trapped in the area, rats (*Rattus rattus*), other murine rodents, and shrews (*Crocidura coerulea*) represented 74, 14 and 12 per cent. Of the 32 per cent. caught that harboured mites, 72 per cent. harboured *Trombicula deliensis* Walch. There were 2–10 mites per animal between January and April and 50–150 in the rainy months (May to November). Young animals were seldom infested, so mites probably do not breed in the nests. The rats and shrews were most frequently and intensely infested with *T. deliensis*, which was found mainly in the ears of the former and on the outer side of the fore and hind legs and on the base of the tail in the latter. Nearly a quarter of the rats taken harboured larvae of *T. deliensis* in large numbers and 20 per cent. of these rats were infected with *Rickettsia orientalis*.

PHILIP (C. B.), TRAUB (R.) & SMADEL (J. E.). **Chloramphenicol (Chloromycetin) in the Chemoprophylaxis of Scrub Typhus (Tsutsugamushi Disease). I. Epidemiological Observations on hyperendemic Areas of Scrub Typhus in Malaya.**—*Amer. J. Hyg.* **50** no. 1 pp. 63–74, 21 refs. Lancaster, Pa., 1949.

TRAUB (R.) & FRICK (L. P.). **V. Relation of Number of Vector Mites in hyperendemic Areas to Infection Rates in exposed Volunteers.**—*Op. cit.* **51** no. 2 pp. 242–247, 9 refs. 1950.

These two parts of a series on the chemoprophylaxis of tsutsugamushi disease contain observations on the Trombiculid mites of the areas of hyperendemicity around Kuala Lumpur, Malaya, where the work was done.

In the first, the results are given of studies on the natural mite populations of the areas, all of which were covered with secondary or scrub vegetation and were heavily infested with native rats carrying large numbers of mites. Mite populations were studied by trapping the native rats, by exposing laboratory white rats in likely habitats and by using a mite-trap [*R.A.E.*, B **36** 208]. *Trombicula akamushi* (Brumpt) and *T. deliensis* Walch were abundant in the areas where cases of tsutsugamushi disease in man were acquired, whereas Trombiculids of other genera were found in areas where no cases were known to have occurred. Although there are no sharp seasonal changes in Malaya, periods of relative drought occur. During one of these, *Trombicula* decreased considerably in numbers, while mites of other genera increased absolutely as well as relatively.

There were marked differences in the numbers of *Trombicula* larvae observed on volunteers and on experimental animals exposed within a few feet of each other even in parts of fields where the vegetation was essentially the same throughout. It seems likely that unfed larvae do not wander far, but become highly active when stimulated by the presence of a prospective host. More than two-thirds of the larvae collected on laboratory rats exposed for 40 hours were engorged. The activity of the larvae during daylight was greatest in the early morning. The numbers collected overnight in the trap, which covers about 1 sq. yard of ground, were 35 on one occasion and 20 on another. An appreciable proportion of the *Trombicula* larvae collected from native rats, exposed white rats and quail were infected with the rickettsiae of tsutsugamushi disease, 18 strains having been isolated from 28 batches of mites. Both the quail shot were very heavily infested with *Trombicula*.

Volunteers were exposed for 5–7 hours daily in fields known to be hyper-endemic foci of infection, and 29 out of 46 exposed on 9 consecutive days when *Trombicula* larvae were prevalent contracted the disease, as did 8 out of 29 exposed for a total of 5·5 days when the larvae were relatively scarce.

The infection rates in unprotected volunteers in five experiments are given in the second paper and compared with data on the Trombiculid infestation of native rats and exposed white rats at the same place and time. It is concluded that, in general, there is a direct relation between the number of infected mites in a given area and the rate of infection with tsutsugamushi disease in people exposed in that area. However, certain methods of estimating the number of vector mites (*Trombicula*) provide data that follow the changing cycle of mite population more closely than others. The factors that should be considered in choosing areas for exposing volunteers appear to be the occurrence of natural cases in the general area, a demonstrated abundance of vector mites on wild rats, the relative ease with which rickettsiae can be isolated from vector mites, the degree of infestation of exposed laboratory rats with vector mites and the proportion of vector to non-vector mites on wild rats. While the number of vector mites infesting captured wild rats is important under ordinary circumstances in forecasting infection of volunteers, fluctuations in the vector populations following periods of drought cannot apparently be detected so rapidly by this method as from the infestation of exposed rats or the proportion of vectors to non-vectors on the wild rats.

Audy (J. R.) & Harrison (J. L.). **A Review of Investigations on Mite Typhus in Burma and Malaya, 1945–1950.**—*Trans. R. Soc. trop. Med. Hyg.* **44** no. 4 pp. 371–395, 2 figs., 35 refs. London, 1951.

Work on the epidemiology of tsutsugamushi disease, carried out by a British research unit at Imphal on the Indo-Burma border from 1945 to 1946 and by another at Kuala Lumpur, Malaya, from 1947 onwards, is reviewed from the literature, including several papers in manuscript or in press.

Only *Trombicula deliensis* Walch and *T. akamushi* (Brumpt) are recognised as vectors of importance to man, and they are possibly forms of one species. *T. deliensis* is the more widespread in Malaya, *T. akamushi* occurring particularly in the east and north of the endemic area. However, the two overlap over a large zone, in which both may transmit infection even in the same focus. Trombiculid mites were the most numerous external parasites of small mammals in all the areas investigated, as well as the richest in species. In Malaya, 42 species were found in forest, 16 in deforested areas and two in the town of Kuala Lumpur, and 17 species were common. The life-cycle of the vector bred through several generations in the laboratory by K. L. Cockings [*cf. R.A.E.*, B **36** 209] lasted 5·5–8 weeks. A study of fluctuations in larval populations in the Imphal area suggested that the cycle of *T. deliensis* in nature during the monsoon was being completed in 8–12 weeks.

The geographical range of the disease is explained by the dispersal of the vectors from their centres of origin until they reached ecological barriers. Within their zone of distribution, they occur in endemic areas and within these in restricted colonies or "mite-islands", sometimes extending only a few yards [*cf.* **41** 6]. These form an irregular pattern decided largely by the behaviour and numbers of the primary hosts and soil factors involving food supplies, natural enemies and microclimate. Not all colonies are infected. In a few colonies, erratically but not fortuitously distributed, the mite-host-mite cycle has been intense enough to allow a heavy infestation of infected mites to develop and also probably to intensify infection in the mites. The centre of distribution of the disease coincides with the centre of evolution and dispersal of the genus *Rattus*, especially the many forms of *R. rattus*, which are the chief hosts of the vectors. Heavy concentrations of infested rodents are associated with neglect of plantations or villages and encouragement of rats during occupation of an area. In nature, infestation is greatest in water-meadows and hedgerows or strips of forest. In the Malayan forest, *T. deliensis* occurs chiefly on the giant rat, *R. mülleri*, a species closely associated with moist soil near streams.

It has been shown that the number of questing larvae of the vectors (and, therefore, the risk of infection) is related to soil moisture and surface humidity, and hence to rainfall [*cf.* **41** 5] and to the lowered humidity that obtains during sunny days and after clearing undergrowth. Even in very dry seasons, larvae persist in foci that are kept moist by ground water. Rainfall affects the distribution of the vectors in both space and time, and also influences the activity of the rodent hosts to a marked extent.

There is evidence of the existence of an enzootic infection in the forests of south-east Asia, probably transmitted by various mites belonging to the same group as *T. akamushi* and constituting a potential risk to man when it involves *T. deliensis* or *T. akamushi* itself. This jungle infection appears to have escaped into the very favourable conditions offered by populous colonies of heavily infested field-dwelling commensal rats, which form most hyper-endemic foci.

During a discussion that follows the paper, K. V. Krishnan (pp. 397–399) recapitulates his findings on tsutsugamushi disease in Barrackpore and on the rearing of *T. deliensis* [**41** 4]. He stated that the growth of fungi in the breeding tubes was prevented by placing one or two small earthworms in each to aerate the soil.

BERTRAM (D. S.). **Studies on the Transmission of Cotton Rat Filariasis. III. A natural Method for quantitative Transmission and its Application to a chemoprophylactic Test of some Drugs; with a statistical Analysis by P. Armitage.**—*Ann. trop. Med. Parasit.* **44** no. 2 pp. 107–123, 8 refs. Liverpool, 1950.

The following is substantially the author's summary of this paper, which is one of a series [*R.A.E.*, B **40** 124, 197] and is concerned with the quantitative estimation of transmission of *Litomosoides carinii*, the filarial parasite of cotton rats [*Sigmodon hispidus*], by small numbers of *Bdellonyssus* (*Liponyssus*) *bacoti* (Hirst).

A sample of at least 50 mites should be dissected before the transmitting meal, to give an estimate of the average number of worms per mite (x) in the series used. Batches of about 20 mites of the series are then released on to separate cotton rats. The gorged mites are collected after 24 hours, the number obtained from each animal (n) is recorded, and as many as are available, up to at least 50, are dissected to estimate the average number of worms per mite remaining (y). The mean number of worms transmitted to

each cotton rat is then estimated from the formula n (x–y) ; n is likely to differ from one cotton rat to another but x and y are constant in any one experiment in which the same series of mites is used. When no gorged mites are recovered, the cotton rat is most likely to remain uninfected or to contain only one worm ; when one or more gorged mites were recovered, 93·5 per cent. of attempted infections were successful. Failures in such cases may simply be due either to the recovered gorged mites being by chance initially negative or to transmissions of only one worm.

The agreement between the expected and the observed infection in the cotton rat is best when mite series are used with infection-rates below 50 per cent. Observed infections are usually lower than expected infections, particularly when heavily infected series of mites are used, because most mites in any series contain few worms and heavily infected mites occur comparatively infrequently. In consequence of this, a mean for a series based on dissections of 50 mites is higher than the mean in most of the smaller lots of mites used for transmission. Male and female adult worms generally occur in equal numbers in the infected cotton rat.

An account is given of the application of this method of quantitative transmission to a test of the chemoprophylactic action of three drugs.

Browning (E.). **On the Occurrence of the Tropical Rat Mite,** *Bdellonyssus bacoti* **(Hirst, 1913)—Synonym** *Liponyssus bacoti* **(Hirst)—in Great Britain.**—*Ann. trop. Med. Parasit.* **44** no. 2 pp. 124–131, 2 pp. refs. Liverpool, 1950.

The presence of *Bdellonyssus bacoti* (Hirst) in Great Britain was not suspected until 1933 when mites of this species were submitted for identification by a London firm of printers whose employees had been bitten by them. During 1934–47, 22 complaints of the mite swarming in buildings and, in most cases, attacking people in them were received, all except one from London. The evidence suggests that the mite has recently been introduced into Britain ; it has been found on and in nests of *Rattus rattus* in London, but not on *R. norvegicus*, the rat that is its principal host elsewhere. Outbreaks with attacks on man have often occurred in buildings in which rats have just been destroyed, and it is assumed that the mites leave the rats' nests in search of food when the nests are deserted. They are believed to be active throughout the year. They move about freely in the day-time but prefer darkness to light. Their bites are painful to man, and irritation sometimes persists for 2–3 days. Notes are given on the distribution and hosts of the mite in other parts of the world and on its possible relation to disease [*cf. R.A.E.*, B **39** 14 ; **40** 32].

Heisch (R. B.) & Grainger (W. E.). **On the Occurrence of** *Ornithodoros moubata* **Murray in Burrows.**—*Ann. trop. Med. Parasit.* **44** no. 2 pp. 153–155, 4 refs. Liverpool, 1950.

Heisch (R. B.). **On** *Spirochaeta dipodilli* **sp. nov., a Parasite of Pygmy Gerbils (***Dipodillus* **sp.).**—*T.c.* no. 3 pp. 260–272, 1 pl., 2 graphs, 18 refs.

Records of the finding of *Ornithodoros moubata* (Murr.) in places in which it is not closely associated with man are rare [*R.A.E.*, B **4** 44 ; **19** 179 ; **31** 207]. Details are given in the first paper of the discovery of several hundred adults of both sexes and nymphs (some in the first stage and unfed) in ten large burrows in three widely separated and practically uninhabited areas of Kenya. The ticks recorded for each burrow were only a proportion of those actually present. Porcupines were the usual inhabitants of the burrows, which had probably been excavated by ant-bears and abandoned. In one of the areas, there were also small burrows inhabited by pygmy gerbils (*Dipodillus*) and

infested with *O. erraticus* (Lucas), but *O. erraticus* was not found in large burrows or *O. moubata* in small ones. To ascertain whether the porcupines were a reservoir of relapsing fever (*Spirochaeta duttoni*), all the examples of *O. moubata* collected and the brains of four porcupines were emulsified in saline and inoculated into white rats. The results were negative, but another spirochaete, only mildly pathogenic for man and monkeys, was recovered from *O. erraticus* and the gerbils.

In the second paper, this spirochaete is designated *S. dipodilli*, sp. n. It was thought that its discovery in an area in which *O. erraticus* and *O. moubata* occur in adjacent burrows might indicate that *S. duttoni* evolved from the rodent spirochaete, and an account is given of studies of its behaviour in *O. moubata*, *O. savignyi* (Audouin) and a Persian strain of *O. erraticus*. All transmitted it by biting, but only occult infections were produced and some of the experimental animals did not become infected. *Pediculus humanus humanus* L. (*P. corporis* Deg.) and *Pedicinus longiceps* Piaget were infected by feeding on infected monkeys, and metacyclic spirochaetes were observed in the former. *S. dipodilli* was shown to be pathogenic to rats, mice, monkeys and young rabbits, but not to guineapigs. Man was only mildly susceptible. There was no cross-immunity between *S. dipodilli* and strains of *S. duttoni*, *S. harveyi*, *S. turicatae*, *S. crocidurae*, *S. merionesi* and *S. microti*, the last three of which are probably closely related, and are transmitted in nature by the same vector (*O. erraticus*). *S. merionesi* is the spirochaete that was isolated from *O. erraticus* in southern Morocco by Baltazard [**25** 276] and *S. microti* is a spirochaete of *Microtus* sp. and *Cricetulus migratorius* in Persia.

BLACK (R. H.). **Anophelism without Malaria in northern Australia : a Malaria Survey of Part of the Northern Territory and the East Kimberleys District.**— *Ann. trop. Med. Parasit.* **44** no. 3 pp. 207–211, 2 pls., 1 map, 2 refs. Liverpool, 1950.

Outbreaks of malaria and suspected malaria in the Northern Territory of Australia since the first white settlement was established in 1824 are reviewed, and reference is also made to the occurrence of a severe outbreak caused by *Plasmodium falciparum* in the East Kimberley district of Western Australia in 1934 and to the finding of *Anopheles amictus* Edw. and *A. annulipes* Wlk. generally distributed in this area in November 1943. Previous malaria surveys have shown parasite-indices varying from 1·8 to 4·4 per cent. in three areas in 1935 and of 33 per cent. (*Plasmodium vivax*) in another in 1945.

An account is given of a survey of a large area of the Northern Territory and Kimberley Division, made in 1949. The spleen-indices for the total white population (121 people) and for 1,382 natives examined were 0 and 0·6 per cent., and no parasites were found in native or white people. No convincing evidence of proved malaria was found in the past history of any of the people seen. Adults and larvae of *Anopheles annulipes*, *A. amictus amictus* and *A. bancrofti bancrofti* Giles and larvae of *A. a. hilli* Woodhill & Lee [*R.A.E.*, B **33** 94] were seen. *A. annulipes* and *A. amictus* were widespread throughout the area, and adults of all three species were taken biting man. Immature stages were found in hoof-prints, soakage-holes in dry river beds, bore-tanks, permanent water-holes in otherwise dry river beds and drainage and ornamental pools. Mosquitos are most prevalent at the end of the wet season (February–April).

The findings are discussed in relation to the proposed development of the area for increased cattle production. It is concluded that the area is potentially malarious, that foci of *P. vivax* giving rise to sporadic cases occur in the Northern Territory and that epidemics of *P. falciparum* appear to be the result of introduction from outside. If the area becomes more densely populated and the amount of surface water is permanently increased, the

introduction of gametocyte-carriers and the spread of *A. farauti* Lav. (*punctulatus moluccensis* Sw. & Sw.), which is the vector in northern Queensland, may result in malaria becoming endemic. Moreover, the species already present may be able to act as efficient vectors, in which case an increase in the population alone might make the disease endemic.

HADDOW (A. J.). **A Note on the Occurrence of *Aëdes* (*Stegomyia*) *simpsoni* Theobald in the Canopy of Rain-forest in Bwamba County, Uganda.**—*Ann. trop. Med. Parasit.* **44** no. 3 pp. 238–241, 14 refs. Liverpool, 1950.

The literature on the transmission of yellow fever in Bwamba County, western Uganda, is reviewed [*R.A.E.*, B **40** 2, 51, etc.], and an account is given of a survey of the mosquito fauna of the forest canopy in the course of which *Aëdes simpsoni* (Theo.), which is a known vector of human yellow fever in the area [**31** 61] and is thought to acquire the virus from monkeys raiding plantations [*cf.* **40** 3], was found to occur in the canopy, where it was, however, scarce. Each catch, of which six were made at each locality, comprised mosquitos taken at human bait in the canopy and at ground level. *A. simpsoni* was represented in the canopy (and at ground level) in 13 (12) out of 40 localities and 26 (29) out of 240 catches. Out of a total of 40,671 mosquitos, only 89 were *A. simpsoni* ; 42 of these were obtained in the canopy at 36–77 ft. Most of the localities in which *A. simpsoni* was taken were near its main breeding-ground in native banana plantations [*cf.* **36** 205].

The scarcity of *A. simpsoni* in the rain-forest is taken to indicate that it cannot be of importance in the monkey-to-monkey cycle of yellow fever and that it is more likely to become infected by biting a raiding monkey in a plantation than by biting monkeys in the adjoining forest. However, its occurrence in the canopy shows that it might occasionally become infected by biting monkeys of such genera as *Colobus* and *Cercocebus*, which, though they are involved in the animal-to-animal cycle, do not raid plantations and virtually never leave the forest canopy.

BERTRAM (D. M.). **A critical Evaluation of DDT and "Gammexane" in Malaria Control in Upper Assam over five Years, with particular Reference to their Effect on *Anopheles minimus*.**—*Ann. trop. Med. Parasit.* **44** no. 3 pp. 242–254, 5 graphs, 7 refs. Liverpool, 1950.

An account is given of investigations made during the monsoons from 1945 to 1949 in Upper Assam to determine the optimum dosages and formulations of DDT and BHC for sprays to leave deposits against *Anopheles minimus* Theo. The area used has a high rainfall and is crossed by the Doom Dooma river and numerous streams. Preliminary tests showed that contact for 5 seconds with deposits from wettable-powder suspensions applied at rates equivalent to 45 mg. DDT or 11 mg. γ BHC per sq. ft. gave complete kill of females of *A. minimus* in 24 and 15 hours, respectively. It was also found that a spray and a liquified-gas aerosol in which pyrethrum extract was the only common constituent were both repellent to the mosquitos, whereas a spray of 3 per cent. n-butyl carbitol thiocyanate in kerosene exercised virtually no repellency and had a quick knockdown action so that it was preferable to use for the collection of mosquitos in treated houses.

Details are given of large-scale experiments on complete and partial treatments of huts having thatched roofs and mud-plaster walls with DDT and BHC in solution, emulsified solution and suspension. All sprays were applied at a rate of 1 gal. per 1,000 sq. ft. The duration of effectiveness of DDT varied considerably with different species of mosquitos, but the effect of BHC on all species was similar. Using emulsified instead of unemulsified solutions or

increasing concentrations of DDT from 1 to 5 per cent. very markedly increased the duration of effectiveness, but with crude BHC (containing about 12 per cent. γ isomer), little change was recorded with corresponding alterations in concentration or formulation. With corresponding deposits, DDT remained effective against *A. minimus* longer than BHC. Against *A. vagus* Dön. and mosquitos of other genera, the action of BHC, particularly in lighter deposits, was noticeably superior to that of DDT. An emulsified solution containing 1 per cent. BHC, which was effective for two months against all species, seemed slightly superior in all-round effect to one containing 1 per cent. DDT, despite the extreme sensitivity of *A. minimus* to the DDT. The experiments further showed that emulsions containing DDT and BHC were considerably more effective than the corresponding kerosene solutions, probably because of the greater absorption of insecticide in solutions into the substance of the sprayed surfaces. The partial treatment of huts indicated that spraying either the inside walls or the ceilings was effective, and that, of the two, spraying the ceilings was the more so, and involved treating a smaller area and one that would not be disturbed by the occupants of the hut. Results of treatment of the eaves (the junction, both inside and outside, of the walls and roofing), were promising and if a heavier dosage (such as 2 per cent. DDT in emulsified solution) should prolong its effectiveness to about the same as that of ceiling-spraying, it might become the method of choice.

The preparations used in tests of suspension sprays were Geigy's DDT malaria spray-powder and Gammexane P.520, and they were applied for complete treatment at concentrations giving deposits of 45 mg. DDT or 11 mg. γ BHC per sq. ft. The effectiveness of complete treatment with the DDT suspension was slightly lower against *A. minimus* and slightly higher against other species than that of treatment with 1 per cent. DDT in emulsified solution. Applied every two months, the suspension should be effective. Complete treatments with the BHC suspension were more effective than with 1 per cent. crude BHC in emulsified solution. There was 90 per cent. reduction or more in all species for at least two months. In tests of the treatment of indoor and outdoor eaves, the concentrations were increased to give deposits of 67 mg. DDT and 16 mg. γ BHC per sq. ft. The DDT effectively reduced *A. minimus* for nine weeks and *A. vagus* for over six weeks, and the BHC gave all-round effective reduction better than that given by DDT. Complete treatment cost twice as much as treatment of ceilings only and nearly three times as much as treatment of eaves, and DDT cost rather more than BHC but was much pleasanter to use.

As it was found on one estate that complete treatment of all labour-line houses four times during the season with 1 per cent. DDT in emulsified solution followed the next season by treatment with DDT in suspension at intervals of two months caused only small reductions in the general malaria rate and in the spleen-rate of children, further study of the effect of spraying on the mosquitos was undertaken. Groups of three huts each, two for treatment and one for control, were used in an experiment designed to determine whether repellency or excitation was taking place. Two men slept in each hut. The only source of light and means of entry for mosquitos was through the eaves. Sheets were spread on the floors, and traps were fitted to specially cut windows facing east. The suspension sprays were used at concentrations giving deposits of 11 mg. γ BHC or 45 or 215 mg. DDT per sq. ft. After the huts had been treated, dead mosquitos were collected daily from the sheets and traps and identified, counted and examined for signs of a blood-meal, and living mosquitos were removed from the traps to observation chambers. The houses were sprayed with thiocyanate every fifth afternoon to record the day-time resting population, if any. Results were recorded over a period of six weeks. The BHC exerted no excitation whatever, as all the mosquitos

found were dead. With a deposit of 45 mg. DDT per sq. ft., 67 mosquitos were found dead and 470 alive. Most of the latter survived more than 24 hours. With a deposit of 215 mg. DDT, 740 mosquitos were found dead, nearly all of them on the sheet, but 215 were found alive in the trap and all these survived more than 24 hours. The experiment was repeated five times with similar results.

Bertram (D. M.). **Larvicidal Treatments with DDT and "Gammexane" in Upper Assam, with particular Reference to their Effect on** *Anopheles minimus*.—*Ann. trop. Med. Parasit.* **44** no. 3 pp. 255–259, 1 ref. Liverpool, 1950.

Larvicides consisting of malariol containing 5 per cent. DDT or enough of a BHC liquid concentrate to give a concentration of 0·25 oz. γ BHC per gal. were tested, mainly against *Anopheles minimus* Theo. in an area of Upper Assam [*cf.* preceding abstract]. The DDT larvicide gave complete control of Anophelines over an observation length of 100 yards when 3 fl. drachms [10·7 ml.] was applied to a stream 2 ft. wide and 6 ins. deep flowing at 12 ft. per minute, complete control over an observation length of 300 yards when 6 fl. drachms was applied to a stream 3–4 ft. wide and 6–9 ins. deep flowing at 38 ft. per minute, and complete control two days after treatment over an observation length of 1,500 yards when 2 gals. was applied to a river 35 ft. wide flowing at 90 ft. per minute. The film persisted longest and was most effective at the greatest distance from the point of application. The same amounts of the BHC larvicide were applied in the same places two years later, and the results are stated to have been identical. In still water, the DDT larvicide at 2 pints per acre gave complete control of all mosquito larvae in 24 hours, and was the lowest dosage that did so. Control remained complete for 10 days when treatment was at 2 gals. per acre. In similar tests, the BHC larvicide gave complete control in 24 hours at 1 pint per acre, and complete control for 12 days at 2 gals.

Hughes (T. E.). **Some Stages of** *Litomosoides carinii* **in** *Liponyssus bacoti*.—*Ann. trop. Med. Parasit.* **44** no. 3 pp. 285–290, 8 figs., 5 refs. Liverpool, 1950.

Details are given of an attempt to trace the development of *Litomosoides carinii* from the time of its ingestion by the mite, *Bdellonyssus* (*Liponyssus*) *bacoti* (Hirst), to the infective larval stage, by means of sectioning mites at various times after they had fed on an infected cotton rat [*Sigmodon hispidus*]. The results are summarised as follows. Some microfilariae migrated from the gut of the mite into the surrounding tissues within 24 hours of ingestion. There are present in the lumen of the gut large cells capable of phagocytic ingestion of the microfilariae in the gut. After migration, microfilariae developed to the infective stage in the parenchyma of the mite, in which the viscera are embedded. The phagocytic cells are probably normally occupied with the formation of the ball-like clumps of non-crystalline black spherules that are later excreted through the anus.

Eichler (W.). **Behandlungstechnik parasitärer Insekten.** [Methods of treating parasitic Insects.]—9 × 6 ins., xiv [+1] + 286 pp., 82 figs., 226 refs. Leipzig, Geest & Portig, 1952. Price *DM.* 19.60.

This book is primarily concerned with arthropods that attack man or animals, and the methods discussed are those mentioned in literature that is not readily accessible or that have a wide general application. The work contains sections on collecting hosts or parasites, laboratory rearing and the use of insects for

tests of the presence or effectiveness of insecticides. A further section deals with the artificial infection of insects and tests with pathogenic organisms and the identification of the latter in them, and includes notes on methods of sampling for population density. Methods of preserving and mounting specimens and preparing slides are described in the final section, which also contains suggestions for arranging and cataloguing collections and descriptions of techniques for examining and identifying specimens.

An appendix contains discussions of formulae for expressing the influence of temperature on insect development, definitions of numerous German technical terms describing host-parasite relations, and notes on the breeding grounds of Anophelines in south-eastern Europe.

ZUMPT (F.). **Wanzenbekämpfung mittels toxischer Wandimprägnierungen.** [Bed-bug Control by Means of toxic residual Sprays.]—*Anz. Schädlingsk.* **22** pt. 8 pp. 121–123, 8 refs. Berlin, 1949.

A brief account is given of experiments with emulsions of Gix, a concentrate containing 60 per cent. fluoro-DDT (DFDT) against bed-bugs [*Cimex lectularius* L.]. Pieces of blotting paper soaked in 1 or 5 per cent. Gix and dried were toxic to bugs confined on them for three days, and remained so for at least 44 days. Although death did not result until 12–14 days after contact with residues that were some weeks old, the bugs were rendered inactive in an average of two and a maximum of four days. In a wooden building near Hamburg, which was used as a hospital and in which fumigation and other methods of disinfestation had proved ineffective, the walls, fittings and mattresses were sprayed with 2 per cent. Gix at a rate giving a deposit of nearly 112 mg. fluoro-DDT per sq. ft. on wooden surfaces. The bugs ceased to be troublesome two days later and had not reappeared after eight weeks. These results are compared with those given by DDT in other countries [*R.A.E.*, B **34** 26, 135, etc.].

WANSON (M.) & LEBIED (B.). **Note sur le cycle gonotrophique de** *Simulium damnosum*.—*Rev. Zool. Bot. afr.* **41** fasc. 1 pp. 66–82, 8 figs., 8 refs. Tervuren, 1948.

Observations on the gonotrophic cycle in *Simulium damnosum* Theo. were made at Leopoldville, Belgian Congo, on females that had emerged from pupae collected in nature and on females that had been taken biting persons infected with *Onchocerca volvulus*. Development of the *Onchocerca* larvae had no direct influence on the developmental cycle of the ovaries. Both types of females needed only one blood-meal to mature their eggs, but engorgement had to be complete. An inadequate meal (less than 0·8–1 mg.) was the usual cause of interruption of the ovarian cycle. Each cycle occupied four days. Oviposition took place 5–9 days after a blood-meal, the number of eggs laid being generally 250–280. A female that has engorged on a host infected with *O. volvulus* can infect another host bitten after oviposition (6 days after the infecting meal [*R.A.E.*, B **36** 148]). In unfed females, the follicles developed to some extent during the first and second days after emergence at the expense of reserves built up in the larval stage, but after this, development ceased and the female normally died on the fourth day. Sugar solution did not prolong life but an inadequate blood-meal did.

The function of the crop is discussed. Ingested sugar solution and fruit juices passed into it, but blood did not [**14** 63]. From a study of the fluid from the crop, which produced in man the same reactions as the insect's saliva, it is concluded that the crop is a reservoir for saliva. The process of digestion of blood and also the female reproductive system and ovarian

development are described. The fact that each ovariole has three follicles suggests that three gonotrophic cycles can be completed, but there is no evidence of this. Only two are known to be completed in nature, and it appears that the females normally live only about a fortnight. The physiological age of females cannot be deduced from any qualitative or quantitative character.

Bibliography of Onchocercosis (includes selected Studies to June 1945). [*In English & Spanish.*]—*Publ. Pan Amer. sanit. Bur.* no. 242, vii + 339 pp. Washington, D.C., 1950.

References, accompanied in most cases by abstracts in English and Spanish, are given to 1,715 papers and monographs published up to June 1945 and containing information on onchocercosis in man or animals, on various species of *Onchocerca* and on Simuliids, whether vector species or not, including papers on the morphology, classification, bionomics, natural enemies and control of the latter. Over 270 species of Simuliids are mentioned individually.

Zahar (A. R.). **The Ecology and Distribution of Black-flies (Simuliidae) in south-east Scotland.**—*J. Anim. Ecol.* **20** no. 1 pp. 33–62, 5 pls., 2 figs., 42 refs. London, 1951.

The following is based on the author's summary. An account is given of the distribution of Simuliids in south-eastern Scotland. *Simulium tuberosum* (Lundstroem), *S. latipes* (Mg.) and *S. monticola* Friederichs inhabit upland streams and *S. tuberosum*, *S. variegatum* (Mg.) and *S. reptans* (L.) semi-upland ones; *S. ornatum* Mg. is widely distributed in all regions. *S. aureum* Fries and *S. equinum* (L.) were abundant in fairly large semi-upland and lowland streams. Occasional records only were obtained of *S. venustum* Say and *S. nölleri* Friederichs. Within their regions, the species chose different habitats. *S. latipes* was found in ditches and small streams, and in medium-sized hill streams in summer, *S. monticola* in hill-streams and *S. variegatum* and *S. tuberosum* in tributary and main drainage rivers. *S. reptans* is a true riverine species.

Distribution depends primarily on the choice of site by the gravid female. Larvae may migrate to secondary sites because of unfavourable conditions or they may be carried away during spates. Females of different species may share a common site for egg-laying. *Simulium* associations were studied in many streams of south-eastern Scotland. The main environmental factors affecting the habitat of the immature stages were the water temperature, the type and rate of current, vegetation, characters of the stream bed, food material and oxygen. The relative importance of these factors is discussed. There is no direct correlation between current velocity and degree of oxygen saturation, and it is concluded that the relation of *Simulium* to current is not determined through the oxygen factor. Accumulation of silt and abundance of bryophytes compel larvae to migrate, and these conditions occur most readily when the current is slow.

S. ornatum, *S. variegatum*, *S. monticola*, *S. latipes* and *S. equinum* hibernate in the larval stage. Development of larvae in winter is accelerated during mild spells. In mild winters, pupation occurs as early as mid-February, but the duration of the pupal stage is prolonged so long as the temperature is low. Mass pupation and emergence of the spring generation occurs when the water temperature is about 10°C. [50°F.]. The summer generation appears in July and August and the autumn generation in September and October. *S. tuberosum* and *S. venustum* probably have one generation a year, *S. monticola*, *S. variegatum*, *S. reptans*, and *S. latipes* have two, and *S. aureum* and *S. equinum* probably have two or three. *S. ornatum* has three in the lowlands and generally only two in the upland areas.

As blood-suckers, Simuliids are less important in Scotland than in many other countries, though *S. reptans* is often reported as troublesome in the Edinburgh district. *S. ornatum*, *S. variegatum*, *S. monticola* and *S. reptans* were observed biting cattle and horses.

DALMAT (H. T.). **Longevity and further Flight Range Studies on the Blackflies (Diptera, Simuliidae), with the Use of Dye Markers.**—*Ann. ent. Soc. Amer.* **45** no. 1 pp. 23–37, 5 figs., 1 ref. Columbus, Ohio, 1952.

In further studies in Guatemala [*cf. R.A.E.*, B **39** 213], carried out from December 1949 to March 1950, totals of 88,867 adults of *Simulium metallicum* Bellardi, 12,338 of *S. ochraceum* Wlk. and 5,422 of *S. callidum* (Dyar & Shann.), the three principal man-biting species of the region, were collected, stained with dyes and released, and 84, 30 and eight examples were recovered at collecting stations. The longest distance between the places of release and recovery was 9·7 miles, and the longest period between the dates of release and recovery was 85 days. Should it be shown that Simuliids infected with *Onchocerca* [*volvulus*] travel as far and live as long as uninfected ones, work designed to prevent the transmission of onchocercosis would have to be extended sufficiently beyond the area to be protected to deal with possible infiltration from neighbouring foci of infection.

BARR (A. R.) & KARTMAN (L.). **Biometrical Notes on the Hybridization of *Culex pipiens* L. and *C. quinquefasciatus* Say.**—*J. Parasit.* **37** no. 4 pp. 419–420, 7 refs. Lancaster, Pa., 1951.

The authors have extended Sundararaman's analysis of the DV/D ratio in the male genitalia of *Culex pipiens pipiens* L. and *C. p. fatigans* Wied. (*quinquefasciatus*, auct.) [*R.A.E.*, B **40** 187] to four hybrid generations and have also back-crossed hybrids with the parent strains. Sundararaman's colonies were the source of the material. The DV/D ratios of the parent strains did not overlap, and those of the hybrids were intermediate. The inbred generations of hybrids showed no tendency to revert to a parental form, but seemed to show increased variability in later generations. The hybrid colonies were maintained through ten more generations with no indication of decrease in vigour, but no further analyses were made. Both sexes of hybrids obtained from crossing *pipiens* males and *fatigans* females were back-crossed with each parent strain. In each case, the offspring were intermediate in DV/D ratio between the hybrid and the parent strain. Some individuals fell within the ranges exhibited by the latter. These results support the view that *pipiens* and *fatigans* are subspecies. Individuals that are presumably hybrid have been found in nature in the United States [*loc. cit.*], but it is not known whether *pipiens* and *fatigans* represent overlapping populations or whether the entire complex is a cline with respect to the DV/D ratio.

PITTENDRIGH (C. S.). **The quantitative Evaluation of *Kerteszia* Breeding Grounds.**—*Amer. J. trop. Med.* **30** no. 3 pp. 457–468, 4 figs., 3 refs. Baltimore, Md., 1950.

In defining the distribution of breeding in bromeliads by species of the subgenus *Kerteszia* of *Anopheles*, it is necessary to consider the intrinsic differences that exist among the various species of bromeliads as potential breeding places, the relative abundance of these species, their vertical distribution (height above the ground), the vertical distribution of oviposition by the Anophelines, and the coincidence or non-coincidence of the vertical ranges of the plants and mosquitos. These factors are considered quantitatively in an analysis of the breeding of *A. bellator* D. & K. in the bromeliad flora of the

immortelle trees [*Erythrina*] in Trinidad cacao plantations [*cf. R.A.E.*, B **37** 42]. Observations were made in the field and also on experimental plots of bromeliads on the ground and on platforms. Whereas the vertical distribution of the plants is determined by light, that of the mosquitos depends principally on humidity. There was a simple correlation between the size of the plant and its larval population, and the ratio of the average number of larvae per plant of a given species to that of *Gravisia aquilega* under conditions of uniform oviposition activity is termed its breeding index, while the product of the breeding index of a species and the average number of plants of that species per tree is the number of breeding units provided by it. The relevant figures for the various species are given in tables and show that the abundance of a species is no direct measure of its importance. The total numbers of bromeliad plants and (in brackets) breeding units per tree were 65·1 (23·5) at all levels and 15·5 (6·3) within 30 ft. of the ground, and *G. aquilega* provided 57·4 per cent. of the total number of breeding units and 76·2 per cent. of those within 30 ft. of the ground. Studies of the vertical distribution of oviposition of *A. bellator* showed that at least 73 per cent. occurred within 30 ft. of the ground. It is concluded that an important reduction in the amount of breeding would be obtained by the selective destruction of *G. aquilega* or of the bromeliads within 30 ft. of the ground.

G. aquilega is the species most easily recognised and reached by men engaged on bromeliad destruction, and control by spraying with copper sulphate [**37** 43] is greatly facilitated if application is limited to a height of 30 ft.

Hall (A. V.). **Short History of Tick Eradication in the British Virgin Islands.**—*J. Amer. vet. med. Ass.* **118** no. 887 pp. 108–110. Chicago, Ill., 1951.

A brief account is given of a campaign for the eradication of *Boophilus annulatus* (Say) carried out in the British Virgin Islands over several seasons. All cattle, equines, sheep and goats were dipped fortnightly in sodium-arsenite dips at a concentration of about 0·18 per cent. arsenious oxide, and as a result the Islands were recognised as free from *B. annulatus* in 1944.

Claborn (H. V.) & Wells (R. W.). **Methoxychlor, DDT, CS-708 and Dieldrin—their Rates of Excretion in Milk.**—*Agric. Chem.* **7** no. 10 pp. 28–29, 115, 8 refs. Baltimore, Md., 1952.

Jersey cows in Texas were sprayed once with a suspension of DDT, methoxy-DDT (methoxychlor) or CS-708 (a 1 : 2 mixture of 1,1-bis(p-chlorophenyl)-2-nitropropane and 1,1-bis(p-chlorophenyl)-2-nitrobutane) or an emulsified solution of methoxy-DDT or dieldrin to determine the amount of insecticide that would appear in the milk. The rate of application was 2 U.S. quarts per animal and the concentration of each insecticide was 0·5 per cent. This concentration is practical for the first three insecticides, but dieldrin would probably be used at a much lower one if applied to livestock. The results are given in tables. Three cows were used in the test of DDT, and the concentration in the milk was greatest (1·8–3·8 parts per million) on the second day. The other treatments were each tested on one cow, except CS-708, which was tested on two. The maximum quantities in the milk in p.p.m. were 0·7 for methoxy-DDT in emulsified solution on the first day, 0·44 for methoxy-DDT in suspension on the second day, 7 for dieldrin on the third day, and 0·92 and 0·83 for CS-708 reached on the seventh and third days after spraying, respectively. The cows treated with methoxy-DDT and CS-708 were sprayed again after 21 and 14 days, respectively, with essentially similar results, except that in one of the cows treated with CS-708 the quantity in the milk was greatest (1·26 p.p.m.) on the second day. For DDT and methoxy-DDT, the averages for all samples taken over a period of 21 days were 1·4 and 0·19 p.p.m.

VINCKE (I. H.) & LELEUP (N.). **Description de la pupe, de la larve et de l'oeuf de *Anopheles concolor* Edwards.**—*Rev. Zool. Bot. afr.* **42** fasc. 3–4 pp. 245–247, 4 figs., 4 refs. Tervuren, 1949. **Un nouvel anophèle dendrophile du Katanga : *Anopheles berghei* sp. nov.**—*T. c.* pp. 248–249, 2 figs., 5 refs. **Notes biologiques et éthologiques sur les anophèles dendrophiles du Katanga.** —*T. c.* pp. 250–258, 15 refs.

The first two papers are concerned with two of four species of *Anopheles* found in forest in Katanga, Belgian Congo, and the third with all four ; the two not mentioned in the titles are *A. dureni* Edw. and *A. implexus* (Theo.). They are closely associated with the forest galleries, remain near their breeding places and probably feed on small mammals. *A. implexus* is less restricted in its ecological requirements than the other species, and sometimes occurs along streams that are relatively little wooded. It and *A. concolor* Edw. occasionally feed on man near their breeding places, but the authors' observations indicate that *A. dureni* does not normally do so. Duren, however, recorded *A. dureni* in huts in Kwango and believed that it fed on man outside them [*R.A.E.*, B **32** 88] ; it is possible that the species has physiological races.

KIRK (R.) & LEWIS (D. J.). **The Phlebotominae of the Ethiopian Region.**—*Trans. R. ent. Soc. Lond.* **102** pt. 8 pp. 383–510, 74 figs., 7 pp. refs. London, 1951.

Generalised accounts are given of the bionomics, relation to disease and control of sandflies of the genus *Phlebotomus* and the morphology of their various stages, and the distribution of the species and varieties recognised in the Ethiopian zoogeographical region is reviewed. Descriptions of these species and varieties are preceded by notes on the structures used in classification, generic and subgeneric synonymy, and points in the synonymy of *P. minutus* (Rond.) [*cf. R.A.E.*, B **31** 245, etc.] and *P. africanus* Newst., which in some cases are not definitely settled. *P. minutus* does not occur in the Ethiopian Region, and most of the records of it there are deemed to refer to varieties of *P. antennatus* Newst. It is concluded that the true *P. africanus* and *P. squamipleuris* Newst., which was described later in the same paper, are identical, and that the *P. africanus* of Adler & Theodor [**14** 96] and all subsequent authors is conspecific with *P. freetownensis* Sinton. To avoid confusion, the suppression of the name *africanus* by the International Commission on Zoological Nomenclature is being requested.

The various schemes that have been proposed for the classification of the Old World species of PHLEBOTOMINAE are summarised. The one adopted is that in which a single genus is recognised, with three Ethiopian subgenera, *Phlebotomus* sens. strict., *Sintonius* and *Sergentomyia* [*cf.* **37** 137]. These are defined, and keys are given as far as possible to both sexes of the Ethiopian species of each. A concluding section contains brief notes on methods of collecting and rearing *Phlebotomus* and keeping adults in captivity.

PHILIP (C. B.) & KOHLS (G. M.). **Elk, Winter Ticks, and Rocky Mountain Spotted Fever : a Query.**—*Publ. Hlth Rep.* **66** no. 50 pp. 1672–1675, 8 refs. Washington, D.C., 1951.

A case of illness tentatively diagnosed at the time as Rocky Mountain spotted fever occurred in November 1949 in the Olympic Peninsula of western Washington in a man who had been bitten by a tick three days before the onset. The diagnosis was supported by the finding of agglutinins for Proteus OX 19 in his serum four months later. This is the first case of Rocky Mountain spotted fever recorded from the Olympic Peninsula. The tick bite was received on the

(184) Wt. P9/3876 3/53 S.E.R. Ltd. Gp. 432 [B] A

day that the man had skinned an infested elk, and the tick, though not identified or preserved, was subsequently stated to resemble a male of *Dermacentor albipictus* (Pack.), which has been recorded from the Olympic Peninsula. *D. andersoni* Stiles, the usual vector in the north-western United States is not known from this part of Washington, and would be unlikely to be active in November. *D. occidentalis* Marx and *D. variabilis* (Say) do not occur so far north, and the time of year is late for *Ixodes pacificus* Cooley & Kohls. The circumstantial evidence that the tick concerned was *D. albipictus* is strong.

Some early experiments in which the infection was transmitted in the laboratory by ticks then identified as *D. occidentalis* are now known to have been made with *D. albipictus*, but this had not been thought to have any practical significance, as *D. albipictus* is normally a one-host tick. However, Howell [*R.A.E.*, B **31** 132] found that horses on infested pasture in California showed definite rhythms in infestation that were not necessarily co-ordinated with equivalent earlier infestations by the preceding stage, and that larvae sometimes dropped from a host after engorgement under experimental conditions.

[Gutzevich (A. V.).] **Гуцевич (А. В.). Contribution to the Question of the Presence of the Ticks *Ornithodorus* in Yugoslavia.** [*In Russian.*]—*Zool. Zh.* **27** pt. 6 pp. 563–564, 3 refs. Moscow, 1948.

During a survey carried out in various parts of Yugoslavia in the first three months of 1947, no ticks of the genus *Ornithodoros* were found in Bosnia, Herzegovina or southern Dalmatia, but 105 nymphs of *O. lahorensis* Neum. were taken on and near sheep in a village some 12 miles north-east of the town of Bitol in southern Macedonia at an altitude of about 2,000 ft. [*cf. R.A.E.*, B **35** 63]. The climate in southern Macedonia is much drier than in the other areas inspected. There is no evidence of the occurrence of tick-borne relapsing fever in Yugoslavia, *O. lahorensis* is not a vector of the disease in Central Asia [*cf.* **34** 205], and no infection was produced in a guineapig on which 15 of the Macedonian nymphs were fed.

[Skuf'in (K. V.).] **Скуфьин (К. В.). Contribution to the Ecology of Tabanids in the Province of Voronezh.** [*In Russian.*]—*Zool. Zh.* **28** pt. 2 pp. 145–156, 2 graphs, 13 refs. Moscow, 1949.

The results are given of studies in 1938, 1939 and 1946 on the seasonal occurrence and abundance of Tabanids in the province of Voronezh, where 28 species were found, and on the effect of meteorological factors on their flight. They were most abundant in woodland that was sometimes flooded and in forest where there were small swamps or marshy glades or where the level of ground water was high. The adults were present from mid-May until observations were discontinued at the end of August and were most numerous from late May to early July. They were most active in 1946, when the weather was less hot and dry than in 1938 and 1939 and the wind, which ranged from slight to moderate, had no appreciable effect on their flights.

In 1939, pools frequented by the flies were oiled [*cf. R.A.E.*, B **24** 301] during a period of hot and dry weather, and the numbers killed in 24 hours ranged up to 500 per sq. metre of oiled surface.

[Korshunova (O. S.) & Piontkovskaya (S. P.).] **Коршунова (О. С.) и Пионтковская (С. П.). About the Virus isolated from the Ticks *Hyalomma marginatum marginatum* Koch.** [*In Russian.*]—*Zool. Zh.* **28** pt. 2 pp. 186–187. Moscow, 1949.

Batches of *Hyalomma marginatum marginatum* Koch collected in a focus of haemorrhagic fever in the steppe zone of the Crimea [*cf. R.A.E.*, B **36** 80]

and others collected, or reared from adults collected, in the mountain-forest zone produced fever in guineapigs on which they fed, and autopsy of the guineapigs revealed slight hyperaemia of various organs and the presence of rickettsia-like organisms in the tunica vaginalis. The batches of ticks from the steppe zone comprised one of adults that had developed from nymphs taken on a hare, one of incompletely engorged adults taken on a bird and three of adults collected before they had found a host. The two batches from the mountain-forest zone comprised nymphs that had partly engorged on hares and progeny of fully fed females taken on cattle. It was thus evident that the infection persisted in the ticks from stage to stage and from one generation to the next.

Three strains of the infectious agent were isolated in guineapigs by injection of suspensions of batches of the ticks that had been collected as nymphs on hares in the steppe zone and maintained by subinoculation. The subinoculated guineapigs reacted in the same way as those infected in the feeding experiments and rickettsia-like organisms were again found in the tunica vaginalis.

The agent from *Hyalomma* was compared by cross-immunity tests with those of other rickettsial diseases that occur in the Soviet Union, including a strain of tick-borne spotted fever isolated from man in Altai, but the results were not conclusive. Thus it immunised against the Altai strain, but infected guineapigs that had recovered from this strain or from the Krasnoyarsk strain [*cf.* **36** 177]. On the other hand, both the Altai and *Hyalomma* strains conferred immunity against Crimean haemorrhagic fever. No test of immunity conferred by the latter was made.

[Petrishcheva (P. A.) & others.] **Петрищева (П. А.) и др. Nests of Birds as Breeding Places of Sandflies** (*Phlebotomus*). [*In Russian.*]—*Zool. Zh.* **28** pt. 3 pp. 284–286. Moscow, 1949.

Various species of birds burrow into soft soil on the sides of ravines, etc., in Central Asia to make their nests, the burrows being over 4 ft. long in some cases. Adult sandflies (*Phlebotomus*) become abundant in the burrows in May and June, but it was not known whether they bred in them. In the summer of 1948, substrata from 113 nests in south-western Turkmenistan were examined, and 8 mature larvae, 25 pupae and 136 pupal skins of *Phlebotomus* were found in eight of them. It is concluded that breeding occurs in the nests, but is only occasional, and that the adult sandflies use the burrows mainly as day-time shelters, especially in spring when the unfledged young in the nests serve as a source of food. Breeding takes place mainly in neighbouring burrows of the gerbil, *Rhombomys opimus*.

[Petrishcheva (P. A.) & Gubar' (V. V.).] **Петрищева (П. А.) и Губарь (В. В.). The Breeding of** *Phlebotomus* **in the Colonies of the large Gerbil** (*Rhombomys opimus* **Licht.).** [*In Russian.*]—*Ent. Obozr.* **30** no. 3–4 pp. 242–245, 5 refs. Moscow, 1949.

Circumstantial evidence that the burrows of *Rhombomys opimus* are breeding places of sandflies (*Phlebotomus*) in the desert regions of the Soviet Union [*cf. R.A.E.*, B **37** 19, etc.] was confirmed in August and September 1948, when 193 larvae, 106 pupae and 605 pupal skins of *Phlebotomus* were found in the substrata from a number of nests of this gerbil in south-western Turkmenistan [*cf.* **39** 204]. The 90 larvae and pupae taken in one of the nests gave rise to adults of *P. papatasi* (Scop.), *P. sergenti* Parr., *P. s. alexandri* Sint., and *P. dentatus* Sint. (*minutus* var. *arpaklensis* Perfil'ev), and adults from pupae taken in other nests also included *P. caucasicus* Marz. and *P. chinensis* Newst. Most of the larvae and pupae occurred at depths of 4–5 ft. None was taken in

new colonies, with but scanty organic matter in the nests, or in old colonies in which the soil was riddled with galleries and the substratum had dried up.

[Lototzkiĭ (B. V.).] **Лотоцкий (Б. В.). An Attempt at a Study of the Chaetotaxy of Ticks of the Genus *Dermacentor* Koch (Ixodidae).** [*In Russian.*]—*Ent. Obozr.* **30** no. 3–4 pp. 276–286, 13 figs., 8 refs. Moscow, 1949.

In view of the possibility that chaetotaxy may be a character of importance in the classification of Ixodid ticks [*cf. R.A.E.*, B **39** 204], the author enumerates the various regions into which the body of the tick can be divided for study of the hairs, gives detailed accounts of the arrangement of the hairs on adults of both sexes and larvae of *Dermacentor marginatus* (Sulz.) and *D. daghestanicus* Olen. and on nymphs of the latter, and suggests a conventional nomenclature for them. He also discusses the characters of the chaetotaxy of Ixodids that are constant and general, and the functional role of the hair cover.

[Denisova (Z. M.).] **Денисова (З. М.). Contribution to the comparative Ecology of blood-sucking Diptera. II. The Significance of the Crop in the Water Balance of Tabanids.** [*In Russian.*]—*Zool. Zh.* **28** pt. 4 pp. 341–344, 3 graphs, 1 ref. Moscow, 1949.

Experiments similar to those carried out on *Anopheles maculipennis* Mg. [*R.A.E.*, B **32** 215] showed that Tabanids are more susceptible to changes in the osmotic pressure of the haemolymph. They lose water more rapidly than mosquitos, but the crop has the same function in controlling the expenditure of ingested water and the concentration of the haemolymph.

[Sosnina (E. F.).] **Соснина (Е. Ф.). On the Survival of Ticks, *Ornithodorus papillipes* Bir., under the Plaster of Walls of local Buildings.** [*In Russian.*]—*Zool. Zh.* **28** pt. 4 pp. 380–382, 3 refs. Moscow, 1949.

The effectiveness of filling up cracks in native buildings in Central Asia with clay against ticks that may be sheltering in them was investigated in Tadzhikistan in experiments beginning on 24th September 1945. Examples of *Ornithodoros tholozani* (Lab. & Mégn.) (*papillipes* (Bir.)) were collected in animal quarters, and some of them were allowed to engorge on a rat. Batches of the fed and unfed ticks, each comprising one male and nine nymphs, were confined in muslin bags and placed in cracks in one of the stone walls of an animal shed, and the wall was then plastered with loess. The bags were removed at intervals ranging from three weeks to a little over a year and the condition of the ticks ascertained. The results, which are discussed and summarised in a table, showed that after a year 72·5 per cent. of the engorged ticks and 52·5 per cent. of the unfed ones were still living, 20 per cent. were dead and the rest had disappeared. In the batch of engorged ticks examined after a year, four were alive, two were dead and four had disappeared, the corresponding figures for the unfed batch being one, one and eight. It appears, therefore, that filling up cracks in the walls might prevent ticks from crawling out and attacking man, but does not give complete mortality, at least in a year.

Wilson (S. G.). **An experimental Study of East Coast Fever in Uganda. III. A Study of the East Coast Fever Reactions produced when infected Ticks 31 Days old are fed on susceptible Calves in limited Numbers over a Period of 3 Weeks.**—*Parasitology* **41** no. 1–2 pp. 23–35, 19 graphs, 3 refs. London, 1951. **IV. A Study of the East Coast Fever Reactions produced when infected Ticks 171 Days old were fed on susceptible Calves in limited Numbers over a Period of 3 Weeks.**—*T. c.* pp. 36–45, 13 graphs, 1 ref.

As cattle infected with East Coast fever (caused by *Theileria parva*) move about until shortly before death, ticks that have engorged on them may infest

pasture over a wide area. In continued investigations in Uganda on the transmission of the disease [*cf. R.A.E.*, B **40** 207], experiments designed to simulate natural conditions were carried out to examine the possibility that non-fatal but immunising reactions could be produced when infected ticks (*Rhipicephalus appendiculatus* Neum.) were fed in small numbers over a period of three weeks on locally reared susceptible Zebu cattle.

In the work described in the first paper, two groups of six calves were used in addition to controls and the ticks, which were infected as larvae, had been in the nymphal stage for about 31 days on the first day of the experiment. One infected nymph was fed on each calf of the first group on the first day, two on the third day and three on the 21st day. Two of the calves developed East Coast fever, with Koch's bodies present in gland smears. The reaction in one was undoubtedly due to the ticks that attached on the first and third days, while that in the other was milder and was probably due to the ticks that attached on the 21st day. Two other calves showed temperature reactions. In the case of the second group, one nymph was fed on the first day, two on the fifth day and three on the 21st day. Five of the calves gave a definite reaction with Koch's bodies in gland smears, four of the reactions being due to the ticks that attached on the first and fifth days. All reactions were mild and recoveries were uneventful.

The immunity of the six calves in the first group was tested 96 days after the beginning of the experiment. Ten infected nymphs were fed on the ears of each. Only one, which had not reacted before, reacted at the immunity test. The calves in the second group were subjected to a more stringent challenge 110 days after the original ticks had fed. Ten infected nymphs were fed on each of them and they were then grazed in a paddock infested with infected ticks. Five proved immune, but one that had reacted before showed a second mild reaction. A susceptible calf treated in the same way developed a fatal infection, but the results with other controls indicated that the strain had become attenuated or that the calves had increased tolerance or resistance.

From the results obtained, it is difficult to assess the minimum intensity of a reaction necessary to give a lasting immunity. Whereas one calf that had shown what appeared to be a definite reaction, reacted again on exposure 110 days later, other calves that had shown apparently similar reactions had not lost their immunity on challenge. Moreover, it is difficult to ensure, by daily observation of temperatures alone, that all calves to be used in an experiment are fully susceptible, as if only a few infected ticks are accidentally introduced into stables or grazing paddocks, subclinical infections are likely to result and the calves may then show varying degrees of resistance to subsequent infection. The intensity of leucopaenia appeared to bear no relationship to the number of days that Koch's bodies were present in gland smears. It was present before the first rise in temperature in all the calves except the one that showed a second reaction on challenge.

In the experiment described in the second paper, nymphs of the same batch were used 171 days after moulting. They were similarly fed on susceptible calves to see if *T. parva* was still viable in them and if the results would resemble those of the earlier work. In the case of the first group of six calves, one nymph was fed on the first day, two on the third day and six on the 22nd day. In the case of the second group, one nymph was fed on the first day, two on the fifth day and six on the 22nd day. Reactions were produced in both groups, but again they were most irregular. One calf in the first group died from extraneous causes early in the experiment. Of the other five, one showed a double reaction and died, one showed a mild reaction, one a doubtful reaction and the other no apparent reaction at all. In the second group, one acute fatal reaction developed but only mild or transient reactions without production of Koch's bodies were seen in the remaining five calves. These mild reactions,

however, appeared to be sufficient to protect against subsequent reinfection when all the calves were grazed in a tick-infested paddock for over a month, beginning on the 44th day of the experiment, whereas all the four survivors of the first group developed reactions and the one that had previously shown the doubtful reaction and one that had shown no reaction died. Six infected nymphs were fed on the ear of each of two control calves on the first day of the experiment and both animals reacted mildly.

It is doubtful if the transient reactions seen in some of the calves could be diagnosed under field conditions, and further investigations as to the infectivity of these types of reactions are needed. In two of the fatal cases, Koch's bodies were absent from all tissue smears at the time of death, and reactions in two of the other calves cast further doubt on the possibility of making a reliable diagnosis by gland smear technique. In general, the results appear to indicate that if the original reaction is mild a second reaction may develop within a few weeks, and that the development of a durable resistance to further attacks may not depend on the presence of Koch's bodies in the peripheral glandular tissues in detectable numbers.

Feldman-Muhsam (B.). **On the Longevity of fasting Ticks,** *Hyalomma savignyi* **Gerv.**—*Parasitology* **41** no. 1–2 pp. 63–65, 1 graph, 7 refs. London, 1951.

Knowledge of the duration of life of fasting ticks of the genus *Hyalomma* is needed to plan campaigns against theileriasis [*Theileria annulata* in cattle] in the Middle East [*cf. R.A.E.*, B **39** 201]. The duration of adult life without food and resistance to various external conditions were studied in laboratory-bred individuals of *H. savignyi* (Gerv.) that had been fed on hedgehogs in the immature stages. They were kept in test tubes under conditions of constant temperature and humidity during observations, which began within 24 hours of the final moult. There appeared to be no significant difference between the sexes in the length of life. At a low temperature (17·5°C. [63·5°F.]) and a high relative humidity (80–95 per cent.), mean length of life approached one year and a few individuals survived more than two years. Length of life decreased as temperature rose and relative humidity decreased, and at 37°C. [98·6°F.], average and (in brackets) maximum durations of life in days were 42·2 (87), 62·6 (99), 103·6 (179) and 106 (132) at humidities of 10, 50, 80 and 95 per cent. Under conditions of extreme dryness (10–20 per cent. humidity), the values ranged from 42·2 (87) at 37°C. to 260 (416) at 17·5°C. Under all conditions tested, the average length of life of adults was 2–30 times as long as that of larvae and 2–7 times as long as that of nymphs [**39** 45].

Baker (E. W.) & Wharton (G. W.). **An Introduction to Acarology.**—$8\frac{1}{2} \times 5\frac{1}{2}$ ins., xiii+465 pp., col. frontis., 2 pls., 377 figs., refs. New York, N. Y., Macmillan Co., 1952. Price $10.

The introductory chapter of this monograph consists of an account of the morphology and anatomy of the Acarina, together with brief notes on the collection and preparation of material for study. The remaining chapters contain keys differentiating all the 228 families of ticks and mites and descriptions of them, a list of genera in each family and their type species, brief indications of distribution and habits, notes on importance in agriculture or public health, if any, and references to relevant literature.

Names are assigned to previously unnamed new species that were the types of three genera proposed by Trägårdh.

Kühl (R.). **Die Prophylaxe in der Dasselbekämpfung.** [Prophylaxis in Warble-fly Control.]—*Anz. Schädlingsk.* **22** pt. 12 pp. 185–190, 13 refs. Berlin, 1949.

Treatment of cattle for the control of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) is compulsory in Germany, where the animals are examined in spring, before being put out to graze, and all larvae found in their backs destroyed. This method is not entirely satisfactory since many larvae already present escape treatment and a considerable number of those of *H. bovis* do not reach the backs of the animals until June or mid-July, when the cattle are at pasture.

An account is given of two experiments in which cattle in mountain pastures were sprayed weekly from late July to September with emulsified solutions of BHC, in an attempt to protect them from infestation. In the first, the animals were sprayed eight times between 28th July and 15th September 1948 and were examined for warbles on various dates between 18th March and 28th July 1949. When the experiment began the average number of warbles per beast was 11·5. The number did not exceed 3·7 during 1949 and was 0 at the latest examination, as compared with 9–12 in neighbouring untreated herds. The second experiment lasted from 30th July to 3rd September 1948, but some animals were deliberately omitted when the herd was brought in for treatment, with the result that the majority were sprayed 4–5 times only. The cattle were classified as to age and examined for warbles on 1st and 30th April 1949. The numbers per animal on those dates averaged 7·6 and 2·7, respectively, for calves, 0·3 and 2·7 for cattle one year old, and 1·4 and 6·2 for cattle two years old, as compared with 21, 17 and 12 on 1st April for the controls. It is concluded that some infestation occurred during the periods between treatments, and that the larvae required less time to reach the back in calves than in cattle two years old. The work showed that spraying is a useful adjunct to the destruction of larvae in spring, and it should be included, together with further examination and destruction of larvae in summer, in a complete programme of control.

Twinn (C. R.). **A Review of Studies of blood-sucking Flies in northern Canada.**—*Canad. Ent.* **84** no. 1 pp. 22–28, 24 refs. Ottawa, 1952.

Much of the work dealt with in this review of recent studies on mosquitos, Simuliids and Tabanids in northern Canada has already been noticed [*R.A.E.*, B **37** 166 ; **38** 143, 155, 167 ; **39** 162, 163, 189 ; **40** 39, 134, 135, 145]. The most troublesome mosquitos in the sub-arctic and arctic are species of *Aëdes*. These have one generation a year and spend the winter in the egg stage below snow and ice in places subject to flooding in the spring. A. S. West showed that adults of *A. communis* (Deg.) that fed on flowers activated with radioactive phosphorus (P^{32}) took up sufficient material, probably nectar, to become highly radioactive [*cf.* **40** 105]. W. O. Haufe reports that data obtained in 1950 indicate that temperature is the most important meteorological factor limiting the activity of mosquitos ; the optimum range for sub-arctic species of *Aëdes* is 55–60°F. with a near optimum extending five degrees above and below, and the low threshold for activity is 36–39°F. Winds of a velocity of 12 miles per hour or more prevent attacks on man, and winds of 7 m.p.h. reduce them by half.

In experiments in 1949 on area control of mosquitos by spraying from aircraft, about 9 sq. miles were sprayed with DDT in oil solution at 0·25 lb. DDT per acre. Two applications were usually necessary, the first against larvae and the second against the adults that survived or invaded the area. Average mortality was 91 per cent. of larvae and 85 per cent. of adults. An experiment in area control by spraying against the adults only was made at Goose Bay, Labrador, in June 1950 when some 19 sq. miles were sprayed with about 0·16 lb. DDT

per acre. The population in the treated area was immediately reduced by about 90 per cent. and it did not exceed 25 per cent. of that in the unsprayed areas for a month. During the year, spraying from aircraft was used successfully against flood-water and other mosquitos.

In 1949 and 1950, thermally generated aerosols containing 5 per cent. DDT and having a mass median particle diameter of 10–20 μ were applied at 20 gals. per hour from a vehicle travelling at 1-2 m.p.h. against both mosquitos and Simuliids. They were effective under suitable conditions, which were provided by a temperature inversion and a wind velocity of 2–3 m.p.h. for open areas and 4–7 m.p.h. for wooded areas. F. P. Ide reported that Simuliid activity diminished with falling temperature and ceased at about 50°F. Times of flight were regulated by wind speed. Biting occurred only during daylight. In May 1950, treatment of a river with 0·1 part DDT per million for 15 minutes [*cf.* **39** 162] practically eliminated Simuliid larvae for 117 miles. There was evidence that the DDT was carried long distances on particles of silt, and dissections indicated that the larvae ingest relatively large quantities of silt.

Ross (R. W.). **The Survival of Yellow Fever Virus in refrigerated Mosquitoes.**— *Ann. trop. Med. Parasit.* **44** no. 4 pp. 299–308, 1 graph, 10 refs. Liverpool, 1950.

Details are given of experiments on the survival of yellow-fever virus in infected mosquitos (*Aëdes aegypti* (L.)) that were allowed to complete the intrinsic incubation period at 30°C. [86°F.] and were then stored at a mean temperature of 1·6°C. [34·88°F.]. The virus survived storage at the low temperature for 32, 6 and 12 days when the mosquitos had been infected at high, medium and low titres, respectively. Statistical analysis showed that the percentage of mosquitos that could be shown to be infective did not drop significantly during four days of storage at the low temperature, but did so during six days.

It thus appears that the transport of mosquitos in a refrigerated state from a possibly infected area to a laboratory for virus-isolation studies would be practicable. It would have many advantages of convenience and safety over their transport alive and active. Since the mosquitos are rapidly immobilised by low temperature, killing them prior to storage is unnecessary.

Gillett (J. D.), Ross (R. W.), Dick (G. W. A.), Haddow (A. J.) & Hewitt (L. E.). **Experiments to test the Possibility of transovarial Transmission of Yellow Fever Virus in the Mosquito *Aëdes* (*Stegomyia*) *africanus* Theobald.**— *Ann. trop. Med. Parasit.* **44** no. 4 pp. 342–350, 22 refs. Liverpool, 1950.

It has been shown that immunity from yellow fever exists in monkeys in small isolated strips of forest in Uganda and that transmission through *Aëdes africanus* (Theo.) and the grivet monkey (*Cercopithecus aethiops centralis*) does not appear sufficient to maintain the virus unaided in isolated areas with a pronounced dry season [see next abstract]. In Northern Rhodesia and Bechuanaland, where the presence of yellow fever has been proved [*R.A.E.*, B **40** 83], the unfavourable season is cold as well as dry, and the maintenance of the virus is still more difficult to explain unless some factor serves to reintroduce it either to the monkey or to the mosquito population. As it is known that the eggs of *A. africanus* can withstand drying for at least 74 days, the possibility of the virus being passed through them from one generation of mosquitos to the next was examined. Detailed descriptions are given of three experiments made to investigate this. In all, 246 wild-caught females of *A. africanus* were fed on three rhesus monkeys (*Macaca mulatta*) that had been inoculated a few days previously with a strain of yellow-fever virus recently isolated in

Bwamba, Uganda ; 108 of them laid 164 batches of fertile eggs, and 1,892 F_1 adults were reared. Yellow-fever virus was shown to be present in 36 of the parents, from which 610 F_1 adults were bred. The F_1 adults were kept individually in separate tubes for a minimum of 18 days from the time of emergence and were then killed and inoculated into mice. The adults that died prematurely were also inoculated into mice. Most of the F_1 females were offered a blood-meal during the first week of adult life. No yellow-fever virus was recovered from any of the F_1 generation.

Ross (R. W.) & Gillett (J. D.). **The cyclical Transmission of Yellow Fever Virus through the Grivet Monkey,** *Cercopithecus aethiops centralis* **Neumann, and the Mosquito** *Aëdes* (*Stegomyia*) *africanus* **Theobald.**—*Ann. trop. Med. Parasit.* **44** no. 4 pp. 351–356, 1 fig., 13 refs. Liverpool, 1950.

Aëdes africanus (Theo.) is known to be concerned in the monkey-to-monkey cycle of yellow fever in the Uganda forests [*R.A.E.*, B **39** 132 ; **40** 51], but hitherto there have been no laboratory studies showing that the virus can be maintained by this cycle alone. An account is given of experiments in which cyclical transmission was twice effected, once through three grivet monkeys (*Cercopithecus aethiops centralis*) and two batches of wild *A. africanus* and once through four batches of laboratory-bred *A. africanus* and four grivet monkeys. In the two cycles, the virus was maintained for 65 and 122 days, respectively. They were terminated through lack of suitable monkeys or mosquitos. The failure of three other attempts to establish cycles of transmission is attributed to the low titre of virus circulating in the monkeys at the time when the mosquitos fed on them.

Grivet monkeys are the only monkeys present in some small forests in eastern Uganda and on some of the islands of Lake Victoria where a high proportion of immunity has been found in them. They can circulate very high concentrations of yellow-fever virus, but even so virus is not detectable in them for more than about six days and is present in sufficient concentration to infect a high proportion of mosquitos for only 1–3. Cyclical transmission depends on the mosquitos being able to feed on these days and subsequently being able to bite a non-immune monkey after an adequate extrinsic incubation period. In the extensive forest of Bwamba, where the monkey population is high and *A. africanus* is active over the greater part of the year, the situation would seem very favourable for the survival of the virus. However, there appears to be an almost equally high proportion of immune monkeys in small isolated strips of forest where the monkey population is more limited and the dry season may be relatively extended so that the mosquito-monkey cycle would seem to be inadequate to explain the maintenance of the virus.

Galindo (P.), Trapido (H.) & Carpenter (S. J.). **Observations on diurnal Forest Mosquitoes in Relation to sylvan Yellow Fever in Panama.**—*Amer. J. trop. Med.* **30** no. 4 pp. 533–574, 8 figs., 21 refs. Baltimore, Md., 1950.

This is the second of a series of publications dealing with investigations on the forest mosquitos of Panama, undertaken because of the occurrence of fatal cases of sylvan yellow fever in man in the Pacora area [*cf. R.A.E.*, B **39** 212]. Records are given of the geographical distribution, annual cycle of abundance and vertical distribution of the forest mosquitos taken attempting to bite man during a study made between February 1949 and February 1950. Collections were made weekly over that period at one station in the Canal Zone and four in the eastern part of the Republic of Panama near Pacora, at altitudes ranging from sea level to 2,100 ft. Each station consisted of a tree with a platform about half way up the trunk and another in the crown, and catches were made

simultaneously from both platforms and at ground level for ten half-hour periods between 8 a.m. and 5.30 p.m. so long as weather permitted. Supplementary collections were made at three other stations in the Republic, one of them in a mangrove swamp, and at two in the Canal Zone, one on an island with open land and scrub. Areas of low and high rainfall were included. The probable relationship of the forest species to yellow fever is discussed.

The forest catches included four species of *Haemagogus*. One of them, *H. chalcospilans* Dyar, was represented by a single individual, but it was taken abundantly biting man in the mangrove swamp, and a fifth species, *H. argyromeris* Dyar & Ludl. attacked man in numbers on the ground in the open on the island. *H. equinus* Theo. and *H. lucifer* (H., D. & K.) were considerably more abundant in the forest than *H. spegazzinii falco* Kumm, Osorno-Mesa & Boshell, a known vector of yellow fever in South America [**39** 173] and were taken in greatest numbers at the stations nearest to where the fatal human cases had occurred. It was shown that the species of *Haemagogus* may be very local in their distribution. The many species of *Aëdes* taken included an undescribed species closely related to *A. leucocelaenus* Dyar & Shannon, another known South-American vector [**39** 191]. It was less abundant than *H. equinus* and *H. lucifer*. However, in view of the small number of cases of yellow fever in the recent outbreak, despite the considerable number of non-immune persons exposed, and of differences in the seasonal distribution of the four species, it is suggested that *H. s. falco* and the undescribed *Aëdes* may be the ones involved in the transmission of the disease to man in this area. As adults of all four species virtually disappeared during the dry season, the question of the method of maintenance of the virus during this period remains open. The only other species against which there is evidence is *Sabethes* (*Sabethoides*) *chloropterus* (Humb.). It was present in significant numbers, its habits showed many of the characteristics of *Haemagogus*, such as a marked preference for the upper levels with only 9·6 per cent. of the catch made from the ground, and it seemed better able to persist through the dry season. There is no direct evidence that it can transmit the yellow-fever virus, but a pool of wild-caught mosquitos including a member of the subgenus *Sabethoides* has been found positive [**27** 121]. A surprising diversity of species of *Anopheles* was taken.

Culwick (A. T.), Fairbairn (H.) & Culwick (R. E.). **The genetic Relationship of the polymorphic Trypanosomes and its practical Implications.**—*Ann. trop. Med. Parasit.* **45** no. 1 pp. 11–29, 10 figs., 12 refs. Liverpool, 1951.

Rats inoculated with mixtures of a strain of *Trypanosoma rhodesiense* and a strain of *T. brucei* developed infections in which the trypanosomes were morphologically distinct from the parent strains when judged by the length frequency-distributions of the three blood forms and were transmissible cyclically by *Glossina morsitans* Westw. [*R.A.E.*, B **40** 52], the metacyclic forms also differing in mean length from those of the parent strains. Cyclical transmission did nothing to restore the original morphology. The mixture of *T. rhodesiense* and *T. brucei* produced similar morphological results *in vitro*, showing that the changes were not caused by any action of the host. Hybridisation is considered as an explanation of these phenomena, with mathematical examination of the data, and it is concluded that, if this is the mechanism responsible, it might be possible by mixing *T. rhodesiense* and *T. brucei* to breed strains non-infective to man. Experiments are described in which this was done, and it is shown that the non-infectivity of the mixed strains to man cannot be due to *T. brucei* " overgrowing " *T. rhodesiense*.

Experiments with mixtures of *T. gambiense* and *T. brucei* are described. They gave similar results, except that *T. brucei* took longer to inhibit the infectivity

to man of *T. gambiense* than of *T. rhodesiense*. Finally, mixtures of *T. gambiense* and *T. rhodesiense* are described. These also were morphologically distinct from the parent strains and readily transmissible by *G. morsitans*, but they remained infective to man. Three strains of polymorphic trypanosomes morphologically identical with the laboratory mixtures of *T. brucei* and *T. rhodesiense* were found in *G. morsitans* taken in nature in Tanganyika. One of these strains was tested in a human volunteer and failed to infect him. Two wild strains of *T. rhodesiense*, recovered from man in Tanganyika, were compared with the laboratory strain of the same trypanosome. The mixture of one wild strain with the laboratory strain showed no variation from the parent strains. The mixtures of the second wild strain with the laboratory strain and of the two wild strains with each other were morphologically distinct from the parent strains. The experimental evidence shows that hybridisation can apparently occur between *T. brucei*, *T. rhodesiense* and *T. gambiense* and thus suggests that they are only variants of a single species. This necessitates changes in nomenclature, for which suggestions are made.

The facts established have far-reaching practical implications. As *T. brucei* can eliminate the infectivity to man of *T. rhodesiense* and *T. gambiense*, any animal capable of carrying *T. brucei* is of potential value as an absorber of the trypanosomes infective to man. While previously uninfected animals can carry *T. rhodesiense* and be a danger to man, this work suggests that those already infected with *T. brucei* will not and that they may be a potent factor in preventing the spread of sleeping sickness. It is suggested that a method of biologically controlling sleeping sickness caused by *T. rhodesiense* may perhaps be perfected by encouraging the spread in the fly-bush of highly transmissible strains of *T. brucei*, at the same time inhibiting the spread of *T. rhodesiense* by treatment of the human reservoir.

CREWE (W.) & O'ROURKE (F. J.). **The biting Habits of *Chrysops silacea* in the Forest at Kumba, British Cameroons.**—*Ann. trop. Med. Parasit.* **45** no. 1 pp. 38–50, 1 fig., 4 graphs, 1 map, 7 refs. Liverpool, 1951.

Observations are recorded on the biting habits of *Chrysops silacea* Aust. at canopy level (50 feet) and at ground level in a single locality in the forest at Kumba, British Cameroons [*cf. R.A.E.*, B **40** 149–150, etc.] in 1950. *Chrysops* was not seen in this part of the forest until the undergrowth had been cleared, after which its biting density there was higher than in the neighbouring European station. *C. langi* Beq., of which three individuals were taken, all in the canopy, is recorded biting for the first time. *C. silacea* fed readily on a man in the canopy, even when others were available in a cleared area on the ground below. It was taken biting only between 7 a.m. and 6.30 p.m. local time. Biting activity showed morning and afternoon peaks and appeared to increase with a rise in temperature over the range 66–85°F. and to decrease with a rise in relative humidity over the range 56–100 per cent. The period of biting corresponds closely with the appearance of microfilariae in the blood of human hosts of *Filaria (Loa) loa*. Sites of the type usually associated with breeding by *Chrysops* were not found in the neighbourhood of the catching station. African *Chrysops* have been observed by the authors to follow a moving vehicle for a mile or more and pursue a pedestrian for about half a mile, and there is evidence that they hunt by sight. Four females of *C. silacea* infected with filariae similar to *F. loa* in the head and proboscis were found in the forest where they were probably feeding on vertebrates other than man. The most likely hosts were canopy-dwelling monkeys, four species of which have been shown to harbour microfilariae and adults of filariae closely resembling *F. loa*.

Davey (J. T.) & O'Rourke (F. J.). **Observations on *Chrysops silacea* and *C. dimidiata* at Benin, Southern Nigeria. Part I.**—*Ann. trop. Med. Parasit.* **45** no. 1 pp. 30–37, 4 graphs, 6 refs. Liverpool, 1951. **Part II.**—*T. c.* pp. 66–72, 2 figs., 16 refs.

A study of the life-history and breeding grounds of *Chrysops silacea* Aust. and *C. dimidiata* Wulp at Benin, Southern Nigeria, was begun in 1946 in view of an apparent recent rapid increase in their number and the occurrence of loiasis [*Filaria* (*Loa*) *loa*] among workers at a research station there. The findings are compared with those obtained at Sapele in Southern Nigeria and Kumba, British Cameroons [*R.A.E.*, B **40** 149, etc.].

In the first of these papers, the area is described and data are given on catches of adults. *C. silacea* and *C. dimidiata* were the only species taken as adults, the latter being the commoner, though 22 out of 38 individuals bred from larvae collected along swampy river banks were *C. longicornis* Macq. Adults were most easily caught near breeding places and much less easily in the homes of Europeans. They were abundant in clearings on the river bank where sand was being dug for building, but were rarely taken in the forest, though they are possibly present in the canopy. They are present in the canopy along the river, though not in such numbers as at ground level. There were no males among the 3,000 caught adults examined, but the sexes were bred from pupae in approximately equal numbers. The adults were abundant in the rainy season (late May to early November). *C. silacea* was present in small numbers from April or May, increased to reach its maximum abundance in July or August when it was the dominant species, and had almost disappeared by October. *C. dimidiata* either appeared early and in equal numbers to *C. silacea* or late, but in either case its numbers rose to a peak in October and November. Comparatively dry periods appeared to favour *C. silacea* and wet months *C. dimidiata*.

Further observations on the habits of the adults are described in the second paper. Biting occurred during daylight with a decrease during the mid-day heat, and one female was taken biting at dusk. Cattle were attractive but men were more so, and groups of people were more subject to attack than individuals. Dark skin was more attractive than white. Adults were occasionally taken more than two miles from a known breeding ground, and tests with marked flies proved a flight range of at least 1,200 yards. The flies have never been seen to follow moving vehicles or pedestrians though they may do so [*cf.* preceding paper]. It is suggested that dispersion takes place at canopy level. All the 300 females dissected had undeveloped ovaries, although most were taken near breeding grounds. It appeared that once a blood-meal had been taken, the flies were completely indifferent to feeding until ovarian development had been completed and the eggs laid.

Hughes (M. H.) & Sarkies (J. W. R.). **The Length of Exposure to Infestation and the Danger of contracting Onchocerciasis.**—*Ann. trop. Med. Parasit.* **45** no. 1 pp. 73–77, 5 refs. Liverpool, 1951.

A high rate of onchocercosis has been feared among people working on hydro-electric schemes in tropical Africa because the rapidly flowing rivers most suitable as sources of water power are also the most suitable breeding-places for the species of *Simulium* that transmit *Onchocerca volvulus*. However, natives of areas where onchocercosis is endemic are nearly all infested with *O. volvulus* and residents in some areas must be frequently reinfested throughout their lives, yet maximum incidence of microfilariae and symptoms is not reached until middle adult life. The evolution of onchocercosis must, therefore, be slow.

In an attempt to assess the danger to workers on schemes of limited duration, the length of exposure needed for microfilariae of *O. volvulus* to appear in eyes and skin was studied in a group of 270 African labourers and 224 children in an infested district near the lower Volta, in the Gold Coast. Nodules occurred with gradually increasing frequency as duration of exposure increased. The incidence of microfilariae of *O. volvulus* in the skin also rose with duration of exposure and had reached 65 per cent. in labourers and 15 per cent. in children in 2–4 years. Among the labourers, the proportion showing microfilariae in the eyes increased similarly but more slowly from 4 per cent. in those exposed for two years or less to 30 per cent. in those exposed for ten years or more. Microfilariae were seen in the eyes of 19 per cent. of children exposed for more than ten years, but in none exposed for less. The incidence of ocular lesions was similar in the two groups, rising gradually to over 20 per cent. in those exposed for more than ten years. The reason for the failure of eye infestation to cause disability in some cases is not known, nor is the probable effect on infested people of moving to a non-endemic area. However, it is concluded that though workers in areas such as that surveyed will probably become infested and some may eventually become blind, the latent period between infestation and the appearance of eye-symptoms is sufficient for detection and treatment if regular examinations are made. Such examinations should be continued for some time after employment has ceased.

Fain (A.). **Simulies nouvelles du Ruanda-Urundi.**—*Rev. Zool. Bot. afr.* **43** fasc. 1–2 pp. 101–123, 29 figs. Tervuren, 1950. **Simulies d'élevage et de capture du Ruanda-Urundi.**—*T. c.* fasc. 3–4 pp. 228–239, 38 refs.

These papers deal with species of *Simulium* collected in Ruanda-Urundi by the author in 1948 and 1949. The first comprises descriptions of eight new species and two new varieties. In the second, brief notes are given on the habits of 17 previously described species (one of them represented by two varieties and one by a variety other than the typical one) together with records of the localities in which they were collected. Five of these species were taken as adults as well as being reared from pupae ; the others were reared from pupae only. Females of *S. damnosum* Theo. attacked man in one locality at an altitude of 2,500–3,000 ft. but were never observed to do so at altitudes of more than 5,000 ft. It is concluded that this species is completely adapted to animals at high altitudes in Ruanda-Urundi, but the reason is not known. No cases of onchocercosis have been diagnosed on the plateaux of Ruanda-Urundi, but two carriers of *Onchocerca volvulus* were found among some 50 fishermen examined near the mouth of the Ruzizi.

Wanson (M.) & Lebied (B.). **Un *Simulium* nouveau du Kwango *Simulium renauxi* nova species.**—*Rev. Zool. Bot. afr.* **43** fasc. 3–4 pp. 309–314, 4 figs., 6 refs. Tervuren, 1950.

Simulium renauxi, sp. n., a species allied to *S. neavei* Roub., is described from females taken biting man aggressively in the Belgian Congo. It occurs on the Kwango and Inzia rivers in the west and has been found as far east as Kanda-Kanda. Of 30 females dissected from a batch taken biting man in the Kwango region, 15 contained developing sausage forms of *Onchocerca volvulus* and three had infective larvae in the head and proboscis. Moreover, *S. renauxi* was far more abundant than *S. damnosum* Theo. throughout a small forest focus of onchocercosis in the territory of Feshi, where both species attacked man and the incidence of *O. volvulus* in human adults was 100 per cent.

Leleup (N.) & Lips (M.). **Un anophèle cavernicole nouveau du Katanga : *Anopheles rodhaini* n. sp.**—*Rev. Zool. Bot. afr.* **43** fasc. 3–4 pp. 303–308, 3 figs. Tervuren, 1950.

Leleup (N.). **Considérations sur l'éthologie et la dispersion actuelle des anophèles cavernicoles du Congo belge.**—*T. c.* pp. 353–355, 1 ref.

In the first paper, the adults of both sexes of *Anopheles rodhaini*, sp. n., and larvae believed to be of the same species are described from the Kakontwe cave (Haut Katanga, Belgian Congo).

In the second, it is recorded that Anopheline larvae were found in nine caves in Bas-Congo in 1949 and adults of *A. vanhoofi* Wanson & Lebied, the only cave-dwelling Anopheline known from the Belgian Congo apart from *A. rodhaini* in three of them. The adults of both species were closely associated with bats, and the larvae bred only in pools the bottoms of which bore a light covering of bat guano. *A. rodhaini* is known only from the type locality. It is thought that it may be very restricted as a result of the destruction of most of the caves of the district by landslides. Species of *Plasmodium* were found in the bats in both districts.

Frizzi (G.). **Genetica di popolazioni in *Anopheles maculipennis*. Studi preliminari sui riordinamenti cromosomici del gruppo.** [Genetics of Populations of *Anopheles maculipennis*. Preliminary Studies on Chromosome Patterns in the Group.]—*Ric. sci.* **19** no. 6 pp. 544–552, 3 figs., 17 refs. Rome, 1949.

The results are given of a study of the patterns of salivary-gland chromosomes of larvae reared from eggs laid by females of *Anopheles maculipennis* Mg. vars. *typicus*, *atroparvus* van Thiel, *labranchiae* Flni., *messeae* Flni., and *sacharovi* Favr (*elutus* Edw.) from various parts of Italy and of larvae that resulted from crossing *atroparvus* with *labranchiae* and *typicus*. It is concluded that although the data do not permit the differentiation of the varieties on this basis, they show that hybridisation between them does not occur in nature.

Russell (P. F.), Bradley (G. H.), Hess (A. D.), Mulrennan (J. A.) & Stage (H. H.) Ed. **The Use of Aircraft in the Control of Mosquitoes.**—*AMCA Bull.* no. 1 [1+] 46 pp., frontis., 21 pls., 68 refs. [New Brunswick, N.J.] Amer. Mosq. Control Ass., 1948.

Knipling (E. F.) Ed. **Ground Equipment and Insecticides for Mosquito Control.**—*AMCA Bull.* no. 2, 98 pp., 30 figs., 3 pp. refs. [Yaphank, N.Y.] Amer. Mosq. Control Ass., 1952. Price $2.

In the first of these bulletins, data are given on types of aircraft and dispersal equipment suitable for applying DDT sprays against larvae and adults of mosquitos and dusts against larvae, rates of application, formulations for solutions, emulsified solutions, dusts and wettable-powder sprays, and operational procedures. There are also notes on the circumstances in which aircraft are useful, on the appraisal of results, and precautions to be taken against injurious effects, and public relations, legislation, liability and insurance. The subjects dealt with in the 16 appendices that make up more than half of the bulletin include equipment, solvents for DDT, and specifications for technical DDT, emulsifiable DDT concentrates, aeroplane DDT insecticide, fuel oil and xylene.

The second bulletin, dealing with the application of insecticides against adults and larvae from the ground, includes sections on the classification and characteristics of insecticide particles ; principles in the atomisation of insecticides ; factors to consider in the choice of insecticides ; available

insecticides (petroleum oils, pyrethrum, DDT, DDD (TDE), methoxy-DDT (methoxychlor), chlordane, BHC, toxaphene and allethrin), equipment (hand-operated sprayers of various types, including aerosol bombs and electric sprayers, power-operated applicators, including fog generators, and hand dusters); the choice and care of equipment; evaluation of results; precautions necessary to prevent harm to man and livestock and to minimise harmful effects on wildlife, beneficial insects and plants, and public relations. The appendices include lists of firms from which insecticide ingredients and equipment for applying insecticides can be obtained in the United States, conversion tables of weights and measures useful in the dilution and application of insecticides, and specifications for petroleum oils, crude BHC, methoxy-DDT, DDD, water-dispersible powders containing aldrin, DDT, crude BHC and γBHC as lindane, emulsifiable concentrates of chlordane, dieldrin, toxaphene, DDT and lindane, a deposit spray of DDT in oil, a dust of DDT and talc or pyrophyllite, and a space spray of DDT and pyrethrum extract.

Hurlbut (H. S.). **The Transmission of Japanese B Encephalitis by Mosquitoes after experimental Hibernation.**—*Amer. J. Hyg.* **51** no. 3 pp. 265–268, 8 refs. Lancaster, Pa., 1950.

The following is virtually the author's summary. Females of *Culex pipiens fatigans* Wied. (*C. quinquefasciatus*, auct.) from a laboratory colony were fed on an emulsion of mouse brain infected with the virus of Japanese B encephalitis and kept under conditions simulating hibernation for 66–91 days, including consecutive periods of 5–15 days at 20–30°C. [68–86°F.], 45–82 days at 8–13°C. [46·4–55·4°F.] and 3–6 days at 30°C. The survivors transmitted the virus by biting young albino mice 66, 90 or 91 days after the infecting feed. The mice developed typical Japanese B encephalitis, and the virus was demonstrated in their brains by bacteria-free passage and by neutralisation test.

It is concluded that *C. pipiens fatigans* and other susceptible species of *Culex* that hibernate as adult females in the temperate zone are probably capable of carrying the virus through the winter and of transmitting it in the spring.

Traub (R.), Frick (L. P.) & Diercks (F. H.). **Observations on the Occurrence of *Rickettsia tsutsugamushi* in Rats and Mites in the Malayan Jungle.**—*Amer. J. Hyg.* **51** no. 3 pp. 269–273, 14 refs. Lancaster, Pa., 1950.

An account is given of studies in which *Rickettsia orientalis* (*tsutsugamushi*) was recovered from the tissues of three species of rats (*Rattus mülleri*, *R. edwardsi* and a species of the *R. rajah* group), which were caught in the primary jungle in Malaya, and from two pools of the Trombiculid mite, *Euschöngastia indica* (Hirst), taken from tree squirrels (*Callosciurus nigrovittatus*) in the same area. This is the first recorded instance of natural infection in these species of rats and in this mite. Tsutsugamushi disease appears to be endemic in certain uninhabited jungle areas and may involve several species of small mammals and mites [*cf. R.A.E.*, B **41** 7].

Davis (D. E.). **Observations on Rat Ectoparasites and Typhus Fever in San Antonio, Texas.**—*Publ. Hlth Rep.* **66** no. 52 pp. 1717–1726, 9 refs. Washington, D.C., 1951.

Rats were collected in San Antonio, Texas, from May 1944 to September 1945 and examined for ectoparasites. *Xenopsylla cheopis* (Roths.), the most common flea, was most abundant from May to August. *Leptopsylla segnis* (Schönh.) was regularly present and was most abundant from March to June and almost absent in July and August [*cf. R.A.E.*, B **38** 38]. *Echidnophaga*

gallinacea (Westw.) was often found on rats in fowl houses at all seasons, and *Nosopsyllus fasciatus* (Bosc) was present in small numbers in the spring. *Pulex irritans* L. was very scarce on the rats, but fleas of the genus *Ctenocephalides*, which are the only ones that commonly attack man in San Antonio, were frequently found on them, particularly in places where cats or dogs were present. Fleas in general were most abundant in May and June, but they remain plentiful for almost six months because of different and overlapping peaks for various species. *Rattus norvegicus* had more fleas than *R. rattus*, and adult males of both species had more fleas than adult females. The number and sex ratios of fleas in stores, mills and dwellings were very similar. For both *X. cheopis* and *L. segnis*, the ratio of females to males was high in the cool season.

Bdellonyssus (*Liponyssus*) *bacoti* (Hirst), the most common mite, was most abundant in March and April, but was never as common as the fleas. *Laelaps nuttalli* Hirst was present in fair abundance and was most plentiful in July and August. A few individuals of *Echinolaelaps echidninus* (Berl.) were found in May and June. The louse, *Polyplax spinulosa* (Burm.), was frequently present on rats, sometimes in large numbers. It was most common from December to February.

The increase in cases of typhus in man occurs about two months after the increase in flea abundance on rats ; in 1944, it began in July. Rats positive for typhus had more fleas than had rats that were negative.

LANE (J.). **Sinonimias en** *Culicoides guttatus* **(Coquillett, 1904).**—*Bol. Ent. venezol.* **8** no. 3–4 pp. 115–117. Caracas, 1950.

Examination of a large number of specimens of *Culicoides guttatus* (Coq.) has shown that it is a very variable species widely distributed over the Neotropical region. Its characters are briefly described on the basis of material from Panama, Porto Rico and several localities in Brazil, and a list of synonyms is given. In addition to *C. diabolicus* Hoffman and *C. filariferus* Hoffman [*cf. R.A.E.*, B **39** 93], these include *C. insignis* Lutz.

PAPERS NOTICED BY TITLE ONLY.

ANDUZE (P. J.) & CAPDEVIELLE (A.). *Anopheles* (*Anopheles*) *guarao* **sp. nov.** [described from larva, pupa and adults of both sexes from Venezuela].—*Bol. Ent. venezol.* **8** no. 3–4 pp. 119–124, 4 figs. Caracas, 1950.

GAINES (T. B.). **The Failure of the Rodenticide Warfarin to injure Oriental Rat Fleas** [*Xenopsylla cheopis* (Roths.)] **when the Poison is fed to the Host Rat.**—*J. Parasit.* **37** no. 5 Sect. 1 pp. 489–490, 3 refs. Lancaster, Pa., 1951.

WINTERINGHAM (F. P. W.). **Separation and Detection of the Pyrethrin-type Insecticides and their Derivatives by Reversed Phase Paper Chromatography.**—*Science* **116** no. 3017 pp. 452–453, 6 refs. New York, N.Y., 1952.

HASSALL (A.), DOSS (M. A.) & HUMPHREY (J. M.). **Index-catalogue of Medical and Veterinary Zoology. Parts 16–18. Authors : T to Zyukov.**—pp. 4987–5711. Washington, D.C., U.S. Dep. Agric., 1952. Prices $1.00, $1.25 & 40 *cts.* (from Supt. Documents), respectively. [*Cf. R.A.E.*, B **40** 192.]

Scott (J. A.) & Blynn (E.). **Observations on Characters for identifying the developmental Stages and for determining the Sex of live Tropical Rat Mites.**—*J. Parasit.* **37** no. 6 pp. 519–524, 21 figs., 8 refs. Lancaster, Pa., 1951.

In the course of experimental work on *Bdellonyssus bacoti* (Hirst), as the vector of filarial worms [*Litomosoides carinii*] of the cotton rat (*Sigmodon hispidus*), it was found that characters such as the size and shape, the structure of the chelicerae, and the length of the peritremes could be used to distinguish the various stages in the life-cycle and the sex in some stages without injuring the mites. These characters are discussed and shown in figures. The male and female larvae are apparently identical. There are distinct differences in the chelicerae of male and female protonymphs, but these are difficult to see in living individuals and are not suitable for the positive identification of sex, which was done by size. When fully engorged with blood, the females are always distinctly larger than similarly engorged males. Deutonymphs can always be distinguished from protonymphs by their chelicerae when examined in water mounts and sometimes even when the mites are moving. The separation of male and female deutonymphs is very difficult. The chelicerae of adults show distinct sex differences and the peritremes also differ in length. All observations on males relate to parthenogenetically produced individuals. It is believed that paired females produce males only parthenogenetically. All males appear identical.

Traver (J. R.). **Unusual Scalp Dermatitis in Humans caused by the Mite, *Dermatophagoides* (Acarina, Epidermoptidae).**—*Proc. ent. Soc. Wash.* **53** no. 1 pp. 1–25, 19 figs. Washington, D.C., 1951.

An account is given of a persistent infestation by *Dermatophagoides scheremetewskyi* Bogdanov of three women who were members of one family. The larva, nymph and adults of both sexes of the mite are described. In the most severe case, that of the author, evidence of infestation began with small itching red papules on the scalp in 1934, and this condition persisted with little change in spite of sporadic efforts at control until 1943, when the symptoms became much intensified. Sensations as of an Arthropod crawling, scratching and biting became very pronounced over wide areas of the scalp and were accompanied by pain and swelling. Later, following the use of mercuric iodide soap as a shampoo, infestation spread to other parts of the body and red papules developed. These yielded to treatment with sulphur ointment. The eyes, nostrils and ears also became involved. The few mites caught were secured by holding a piece of sterilised cotton, dipped in lysol solution for several minutes over a place where movement could be felt, and a few, mostly dead, were also collected from the pillow in the morning following treatment of the scalp the day before. It is believed that the mites burrow into the dermis but occasionally come to the surface, and sometimes, particularly as a result of disturbance by treatment, migrate and re-enter the skin at a different place.

Very many substances, including those commonly used against scabies, were tried for treatment with varying degrees of success. Those that gave relief, but often only for a short time, included 15 per cent. sulphur ointment, which could be left on the scalp or other parts of the body for several days and was one of the most helpful substances used, a 2–5 per cent. aqueous solution of Gentian violet, which eradicated small colonies of mites on wrist, knee, fingers and below the ear if left on for 7–10 days and reinforced every few days, a relatively strong solution of lysol, which killed the adult mites but can be used only on small areas, 1 per cent. mercuric iodide soap used as a shampoo,

(305) Wt. P9/3876 4/53 S.E.R. Ltd. Gp. 432 [B]

benzyl salicylate, 2-phenylcyclohexanol and benzyl benzoate. The most acute phase of the infestation yielded to treatment within six weeks, but eradication was not achieved. It is not known whether this failure is to be attributed to a greater resistance to strong chemicals in this mite as compared with common parasitic species or to greater inaccessibility.

A note is appended on another case of infestation of the scalp and body in several members of one family, in which the mite was found to be *Leiognathus* (*Bdellonyssus*) *sylviarum* (C. & F.).

TRAVIS (B. V.) & SMITH (A. L.). **Tests with Repellents against the Stable Fly.**—*J. Amer. vet. med. Ass.* **119** no. 894 pp. 214–216. Chicago, Ill., 1951.

In field tests of a small number of repellents applied to the arms and legs against *Stomoxys calcitrans* (L.) in Florida in October 1942, Indalone [*cf. R.A.E.*, B **36** 46] and pinene ether of glycol were outstanding, giving protection for 2–3 hours or longer. However, the latter was rather irritant. When the materials were redistributed after each bite, the repellent time usually decreased from one bite to the next, but enough remained after the second bite to provide considerable protection. Laboratory tests of about 100 potential repellents were made from 1942 to 1945. Arms were exposed for three minutes immediately after treatment, again in about 15 minutes and at intervals of about 30 minutes thereafter. Only about 20 of the repellents were effective for an hour or more ; the best were 2-phenylcyclohexanol, with an average repellent time to the first bite of more than 322 minutes, Indalone with one of more than 246 minutes and p-methoxyacetophenone with one of 196 minutes. Dimethyl phthalate and 2-ethyl-1,3-hexanediol (repellent 6–12) were relatively ineffective in both field and laboratory tests, and the addition of thickeners to them did not increase repellent time.

ADAMS (P. G.), CASTILLO (C. H.) & SALMERON (R.). **Application of Toxaphene for Torsalo Fly Control.**—*Agric. Chem.* **7** no. 12 pp. 33–35, 119, 121, 123, 5 figs. Baltimore, Md., 1952.

Dermatobia hominis (L. jr.), the most serious insect pest of cattle in Central and South America [*cf. R.A.E.*, B **35** 183 ; **38** 85, 86], has been causing damage in Nicaragua for at least 26 years. Infestation retards the growth and development of young animals, causes anaemia and digestive disturbances, lowers milk production, reduces the quality and yield of meat, damages the hides and even results in death. The individual larvae remain under the skin for some 35 to 80 days.

Experiments were made on two farms to investigate whether a deposit from a spray containing 0·5 per cent. toxaphene in emulsified solution would reduce infestation by killing the larvae before they enter the skin or possibly the Diptera that carry the eggs. The spray was applied to cows at the rate of 2·2 pints per animal with a low-pressure knapsack sprayer, and one group of cows on each farm was sprayed every 14 days, a second was sprayed every 28 days, and a third was left untreated. On one farm, the average numbers of larvae per animal in an area six ins. square on the shoulder and fore-rib at the beginning of the experiment and 2 and 6 months and 252 days later were 13·25, 1·88, 0·25 and 0·62 in the first group, 17, 6·5, 2·87 and 1·75 in the second, and 12·25, 10·5, 8·62 and 7·5 in the third. On the second farm, the average numbers at treatment and 3 months, 4 months and 168 days later were 8·6, 0·25, 0·75 and 0·66 in the first group, 3·75, 1·75, 0·75 and 0 in the second, and 7·62, 5·75, 5·56 and 5 in the third. On the first farm, the animals in the three groups had calculated average weights of 973, 987 and 938 lb. at the beginning of the experiment and 1,030, 974 and 882 lb., respectively,

after 252 days. On the second farm, the weights averaged 947, 1,036 and 1,024 at the beginning and 963, 1,057 and 1,050 after 168 days. All the cows in the second group on the first farm were in fair but satisfactory condition after 252 days, while four of the eight in the third had become so emaciated and weak as a result of heavy infestation both by *D. hominis* and fever ticks [*Boophilus annulatus microplus* (Can.)] that the experiment was terminated to prevent their death. The average number of larvae of *D. hominis* per animal extracted by hand at the close of the experiment from cattle treated every 14 and 28 days and controls was 2·62, 17·85 and 173·5 on the first farm and 5·33, 25 and 43 on the second. The tumours began to heal soon after the larvae emerged from them and needed only a few weeks to heal completely. The toxaphene deposit apparently prevented reinfestation when the spray was applied fortnightly. The more frequent treatment gave more satisfactory control of ticks. On the basis of these results, an area control programme was begun in December 1950.

In subsequent tests, a commercial formulation (Smear EQ335) containing 3 per cent. γ BHC as lindane and 35 per cent. pine oil applied with a stiff brush to the tumours proved 93 per cent. effective in either killing or eliminating the larvae in them [*cf.* **38** 86].

DE TOLEDO (A. A.). **Notas sôbre a biologia e contrôle do berne.** [Notes on the Biology and Control of *Dermatobia hominis*.]—*Biológico* **14** no. 11 pp. 264–267. São Paulo, 1948.

DE TOLEDO (A. A.) & SAUER (H. F. G.). **Efeito de alguns inseticidas clorados sôbre o berne.** [Effect of some Chlorinated Insecticides on *D. hominis*.] —*Op. cit.* **16** no. 2 pp. 25–34, 2 figs., 6 refs. 1950.

Investigations on the bionomics and control of *Dermatobia hominis* (L. jr.), a serious pest of cattle in São Paulo, Brazil [*cf.* preceding abstract, etc.], were begun in 1948. In the work described in the first paper, three batches of larvae that left their hosts (cows) in June, July and September were used in laboratory studies on the life-cycle. The time taken to enter the soil (prepupal stage) was 1–2 days, and the pupal stage in the three batches averaged 58, 51·3 and 36·5 days, respectively. The adults survived for averages of 6·3, 7·6 and 5·7 days. The preoviposition period lasted about two days, and eggs, which are normally deposited on other Diptera, were laid in the laboratory on paper and the sides of the cage. The numbers per female averaged 205, 138 and 183, respectively. The egg stage varied from 12 days in September to five in November, and the larvae penetrated the scraped skin of guineapigs in about four minutes. The larval stage averaged 34 days in rabbits and 44 in guineapigs, so that a generation was completed in about 100 days.

Insecticides were tested on infested guineapigs when the larvae were 8–30 days old. When used for local treatment, an ointment containing 1·3 per cent. γ BHC gave complete mortality of larvae of all ages and was superior to ointments containing 1 per cent. parathion or 0·8–1·6 per cent. nicotine as nicotine sulphate, but nicotine sulphate at the same concentrations in mineral oil killed all larvae 25 and 30 days old, the only ones against which it was tested. In dips, 0·5 per cent. γ BHC gave complete mortality after immersion for 5 or 10 minutes and was again superior to nicotine sulphate ; parathion at 0·2 per cent. killed the guineapigs. A dust of 2 per cent. γ BHC in talc killed all larvae 8–25 days old and 67 per cent. of those 30 days old. The BHC ointment gave complete mortality of larvae when applied to an infested cow, and a dust of 6 per cent. γ BHC applied to two cows killed most of the larvae.

It is reported in the second paper that BHC proved superior to DDT, toxaphene and chlordane in further tests with ointments, and experiments

on the toxicity of these materials when ingested by the larvae are described. These were preceded by tests with *Musca domestica* L. and blowflies. Larvae of *M. domestica* were reared on crushed straw moistened with a mixture of milk and water (3 : 1) in which the insecticides (in almond oil) were incorporated at 1 : 500,000. All reduced the numbers of pupae and adults obtained per 100 larvae, γ BHC doing so the most, and all except DDT reduced the average length of life of the adults, chlordane giving the greatest reduction, as compared with the controls. In the tests with the blowflies (Sarcophagids and Calliphorids), γ BHC, toxaphene and chlordane were injected in almond oil into guineapigs at 20 mg. per kg. body weight, and the animals were killed after 24 hours and exposed to infestation by the flies. Pupae were collected 14 days later and kept for adult emergence. Chlordane was the only material to give any appreciable reduction in the percentage emergence and the average survival period of the adults, and its toxic effects in the latter were severe. It killed all the larvae of all but one of the species of blowflies used.

In similar tests against *D. hominis*, γ BHC was injected in solution into infested guineapigs at 10–100 mg. per kg. The guineapigs were not affected, except in one doubtful case, and the percentages of larvae killed were 46·4, 40·7, 75·5 and 68·1 for dosages of 40, 50, 60 and 100 mg., respectively ; 10 or 20 mg. γ BHC was not toxic. Larvae that survived treatment with BHC gave rise to abnormal adults. Chlordane at up to 100 mg. and toxaphene at 10 mg. per kg. had little or no effect on the larvae, but the chordane treatments resulted in complete mortality in the prepupal or pupal stage. Toxaphene killed two of the five guineapigs used.

In preliminary tests on infested cattle, γ BHC was injected hypodermically at 5 and 10 mg. per kg. body weight or ingested at 10 mg., and the larvae that left the hosts were collected. The percentage emergence of adults was about the same as for no treatment, but all the adults obtained were abnormal and none laid viable eggs. The results of a similar test with chlordane was inconclusive, but resembled those obtained in guineapigs. A test with γ BHC was then carried out on cattle in the field, 5 and 10 mg. per kg. being injected or ingested at intervals of 20 days. After three treatments, the numbers of tumors per animal averaged 12·3, 3·6, 9·6 and 0, respectively, as compared with 26 for no treatment. When 10 mg. per kg. was similarly injected, the numbers of tumors after 60 days averaged 4 for γ BHC, 14·5 for chlordane and 52·7 for no treatment.

QUTUBUDDIN (M.). **The Emergence and Sex Ratio of *Culex fatigans* Wied. (Diptera, Culicidae) in Laboratory Experiments.**—*Bull. ent. Res.* **43** pt. 4 pp. 549–565, 3 figs., 23 refs. London, 1953.

The following is mainly based on the author's summary. In view of the great diversity of opinion as to the sex ratio of mosquitos and order of emergence of the sexes, both in the laboratory and in nature [*cf. R.A.E.*, B **10** 208 ; **11** 37, 38 ; **14** 177 ; **18** 231 ; **22** 142 ; **23** 218], 70 experiments were carried out in the laboratory at room temperature (about 65–87°F.) between January and December 1950 to study the order of emergence of the sexes, the proportions of the sexes in the total output in a brood and the effect of larval and pupal mortality, larval food and temperature on sex ratio. *Culex pipiens fatigans* Wied. was chosen for the work. It is shown by a statistical evaluation and graphical representation of the data obtained that males emerge significantly earlier than females and complete the larval stage in a significantly shorter time, whereas there are no appreciable differences in the durations of the egg and pupal stages in the two sexes. In the experiments as a whole, the sexes emerged in approximately equal numbers, though there was a significant preponderance of one sex or the other in a small number of aberrant cases.

There was evidence that mortality of less than 20 per cent. in either larvae or pupae does not affect the sex ratio ; and it was not found possible to establish any relation between sex ratio and mortality in any of the larval instars. Though the effect of food was not studied extensively, the few experiments carried out indicated that the proportion of the sexes is not likely to be affected by the kind or quantity of food supplied. The effect of temperature on sex ratio under controlled laboratory conditions was not specially studied. However, it was not possible from the experiments carried out to deduce any correlation between the mean temperature and the proportion of the sexes.

SIPPELL (W. L.) & BROWN (A. W. A.). **Studies of the Responses of the Female *Aëdes* Mosquito. Part V. The Role of visual Factors.**—*Bull. ent. Res.* **43** pt. 4 pp. 567–574, 1 pl., 7 refs. London, 1953.

In this fifth paper of a series, the importance of visual factors in attracting females of *Aëdes aegypti* (L.) is considered in comparison with that of the air-borne factors studied in earlier ones [*R.A.E.*, B **39** 189 ; **40** 39]. They were investigated by exposing moving or anaesthetised deer-mice (*Peromyscus maniculatus bairdii*) in transparent or opaque, airtight or perforated, plastic containers, and by observing the effect of black and white surfaces and evaluating mirroring effects. The visual factors proved to be approximately equivalent to the air-borne emanations in attracting the mosquitos to the deer-mice. They were slightly the more attractive when the animals were moving normally and the less attractive when they were anaesthetised. The visual attractiveness of a deer-mouse moving normally was 1·8 times as great as that of one immobilised by anaesthesia. Tests with dull black cylindrical canisters showed that, with inanimate objects also, nearly twice as many mosquitoes are attracted to a moving as to a stationary body.

Mirroring surfaces were significantly more attractive than dull ones, a black enamel surface was 42 per cent. more attractive than flat black, and a silvered mirror was 55 per cent. more attractive than a lacquered metal surface. It was found that the attractiveness of a black surface could be enhanced by the movement of lines of shadow, but not of points of light, across it. The attractiveness of cubes painted with alternating stripes of black and white increased with the ratio of black to white [*cf.* **28** 167]. The attractiveness of cubes painted with alternating square checks of black and white, increased as the size of the checks decreased and the black-white interface or " contour " lengthened, although there were equal amounts of black and white in all cases. For the same proportion of black to white, and for the same amount of black-white " contour ", stripes and checks were equal in attractiveness.

DRESDEN (D.) & OPPENOORTH (F. J.). **Residual Effect, Skin Application and Injection of γ -Hexachlorocyclohexane in *Drosophila melanogaster*.**—*Bull. ent. Res.* **43** pt. 4 pp. 581–586, 4 graphs. London, 1953.

The two important aspects of the study of strains of insects resistant to insecticides are the development of resistance, which is a genetical problem, and the difference between normal and resistant individuals, which is a physiological problem. It would be of interest to use *Drosophila melanogaster* Mg. for studies of the genetical problem, as it is well known genetically and is closely related to *Musca domestica* L., in which the most outstanding examples of resistance are to be found, although its small size is a disadvantage in physiological investigations. It was accordingly used in the experiments here described, which are concerned with the evaluation of experimental procedures. The insecticide used was γ BHC because physiological investigations on its action are in progress. It was tested by injection of an emulsified solution,

topical application of acetone solutions to the skin, and exposure of batches of about 50 insects for 24 hours in test tubes lined with filter paper impregnated with a deposit from an acetone solution. The methods used are described with particular attention to the technique of injection and the manner of estimating regression lines. The median lethal doses by injection and topical application were 0·00141 and 0·0099 mmg. γ BHC per insect, respectively ; by the contact method they were 1·71 mmg. per 90 sq. cm. for the mutant strain used for the topical and injection tests and 2·18 mmg. per 90 sq. cm. for a Berlin inbred strain. The reproducibility of the results obtained is briefly discussed. It was found that in the case of the skin-application and injection methods, the regression line did not deviate significantly from linearity. The same was true for the contact method if the results obtained with the smaller doses were not taken into consideration.

LEWIS (D. J.). *Simulium damnosum* **and its Relation to Onchocerciasis in the Anglo-Egyptian Sudan.**—*Bull. ent. Res.* **43** pt. 4 pp. 597–644, 1 pl., 44 figs., 4 pp. refs. London, 1953.

The following is substantially the author's summary. Observations were made chiefly in the southern Sudan, particularly at Mvolo where *Onchocerca volvulus* is common in man. The country and climate are described briefly, and methods at some length. The distribution of *Simulium damnosum* Theo. in the Sudan and the places where it is known to be abundant are shown on a map. It does not appear to exist at the Fola Rapids.

Changes in certain organs of the fly were studied, chiefly in relation to the approximate estimation of age and (particularly in the case of the mid-gut and peritrophic membrane) to the movement of microfilariae of *O. volvulus*. Recently emerged flies can often be readily detected by the clarity of the halteres (in which glycogen has not yet been stored) and the presence of abundant fat body, and by less conspicuous features such as the absence of an old peritrophic membrane. The oesophageal diverticulum often contains plant sugars and particles of grit but never blood. The peritrophic membrane is formed at the time of a blood-meal by the epithelium of the expanding part of the mid-gut. It is a laminated chitinous envelope completely surrounding the blood and remains unbroken for 24 hours or more. When very large numbers of microfilariae are ingested, they appear to prevent the completion of the membrane so that blood quickly passes to the hind-gut.

The main breeding season in the southern Sudan is during the rains when the rivers are in flood, and in the north it is in the dry season on a falling river. *S. damnosum* breeds mainly in rapids, but also in quiet stretches of rivers [*cf. R.A.E.*, B **39** 178]. In the south, the adults are widespread during the rains but restricted to patches of bush in the dry season. They probably live longer in the rains, though it appears that a few may live for a considerable period during the dry season. They can probably fly or drift on the wind for 18 miles or more in the Sudan. Material ingested by the females includes human blood and small particles of other tissue, plant sugar, microfilariae of *Onchocerca volvulus* and *Filaria* (*Acanthocheilonema*) *perstans*, particles of grit, and occasionally pollen grains. Females do not bite when the ovaries are developing, that is, they do not feed more than once in two or three days. They rarely if ever make interrupted blood-meals. They bite in bush or open country, on level ground or hill tops, and in sunshine or under shady trees, but less in thick herbage than in the open. Very few bite in moderately dark buildings. Biting continues from before sunrise till after dusk, but increases in the afternoon. One female can lay over 500 eggs.

Parasites other than *O. volvulus* found in *S. damnosum* included various protozoa and nematodes in adults and larvae, and a planidium larva, probably

a species of *Perilampus*, in adults. Only the planidium and a species of *Mermis*, which was found in larvae, pupae and adults, were common. A few of the flies were infested by mites.

Human onchocercosis occurs along the middle reaches of southern rivers before they reach the great swamps. It is much less widespread than *S. damnosum*, which occurs without the disease in the northern Sudan and on southern streams. The infected area, although large, is relatively unimportant and unproductive, and no towns are seriously affected. The reported incidence of blindness ranges from less than 1 to about 10 per cent. of the population. *S. damnosum* is considered to be the sole vector. At Mvolo during the rains, the average rate of infection of the Simuliid by developing larvae was 12 per cent. The highest rate observed in one day was 36 per cent. with a head infection of 8·5 per cent. The highest percentages for part of a day were 40 and 10. Infected Simuliids were found at various distances from the river Sue up to 20·5 miles. Some of these had bred in tributary streams, but the findings showed that there is a wide belt along this river in which people can become infected. The rainy season is known to be the main season of transmission because the fly is widely distributed then and the infective stage of *O. volvulus* is common. In the dry season, *S. damnosum* disappears from most of the infected areas and becomes scarce and restricted in distribution in the remainder. There is evidence that the infection rate falls in the dry season, possibly owing to the effect of atmospheric conditions on the length of life of the Simuliid. The risk of onchocercosis spreading to the north cannot be ruled out, but there is no reason to think that it can become established in the arid northern Sudan.

The average number of microfilariae ingested by a fly is considerably greater than that of larvae (about three) that complete development to the infective stage. Observations showed that most of the microfilariae become enclosed by the peritrophic membrane and stay in it till they die. Some remain in the tubular part of the mid-gut when the membrane is forming in the expanding part, and it is thought that a few of these pass into the peritrophic space, penetrate the epithelium of the expanding part of the mid-gut and make their way to the thoracic muscles. In very heavily infected flies, some of the microfilariae appear to prevent the completion of the membrane and force their way into the hind-gut and up the Malpighian tubes, from which they escape and probably spread to many parts of the fly and kill it.

Radical control of *S. damnosum* by larvicides is impracticable owing to the volume of the rivers and the size and nature of the country. Removal of villages from rivers is impracticable owing to the waterless nature of the country inland, but it might be feasible for people to move inland during the rains when surface water is obtainable and for wood-cutting gangs to operate only during the dry season. The choice of sites for new settlements should be based on several years' experience, as the numbers of the Simuliid can fluctuate from year to year. The use of slightly darkened buildings and protective clothing is of some value. Dimethyl phthalate is very valuable as a repellent if carefully used and can given complete protection.

JACKSON (C. H. N.). **Seasonal Variations in the Mean Size of Tsetse Flies.**—*Bull. ent. Res.* **43** pt. 4 pp. 703–706, 1 graph, 7 refs. London, 1953.

Observations on the mean size of non-teneral males of *Glossina pallidipes* Aust., *G. swynnertoni* Aust. and *G. morsitans* Westw., were made on flies from untouched control areas near Shinyanga, Tanganyika. Mean size (assessed by mean vein length [*R.A.E.*, B **34** 198]) was found to be negatively correlated with the mean saturation deficit at 2 p.m. two months before. This was expected

as the mean male pupal period is 35 days at Shinyanga temperatures (23°C. [73·4°F]) and the mean age of the males measured was judged to be 3–4 weeks ; it is known that the size of individual offspring is determined at birth and is not affected by conditions during pupal life. The correlation was highest (—0·9) for *G. pallidipes*, the largest species, and lowest (—0·68) for *G. swynnertoni*, the smallest. The variation coefficient of mean vein length also was highest for *G. pallidipes* and lowest for *G. swynnertoni*. The correlation between mean size of *G. pallidipes* and mean saturation deficit one month before measurement was —0·32 and with no lag at all, it was —0·24. The correlation with maximum temperature of two months earlier was somewhat but not significantly lower than that with saturation deficit. It was —0·79 for *G. pallidipes*.

PRINGLE (G.). **The Sandflies (Phlebotominae) of Iraq.**—*Bull. ent. Res.* **43** pt. 4 pp. 707–734, 11 figs., 1 graph, 2 maps, 12 refs. London, 1953.

The results are given of a survey in 1949 and 1950 of the species of *Phlebotomus* of Iraq. Of the 12 species found, four belong to *Phlebotomus, sens. str.*, and eight to *Sergentomyia*, which is accorded generic status, as Theodor's classification [*R.A.E.*, B **36** 133] is followed. Two new species and two new varieties of *Sergentomyia* are described ; they include *P.* (*S.*) *sintoni*, sp. n., which is believed to be the species recorded as *P. minutus* (Rond.) from Pakistan in papers by Sinton [**20** 233 ; **22** 11]. A male of *P.* (*S.*) *palestinensis* Adl. & Thdr. taken in Baghdad is described, as it differs from the male described from Palestine [**35** 148]. Tables are given showing the distribution of the 12 species within Iraq and of these and other species in neighbouring territories, and keys for the identification of the species dealt with are included.

The areas in which dermal leishmaniasis (*Leishmania tropica*) is endemic in man and the places in which each of the four species of *Phlebotomus sens. str.* occurs are shown on a map ; the evidence given lends support to the belief that *P. sergenti* Parr. is the principal, if not the only, vector in Iraq. The reasons for the absence of this species from the southern part of the country are discussed. It is thought that the soil-water level is the limiting factor, and if this is so, effective drainage of urban areas in the plains of Iraq might be followed by disappearance of the sandfly and consequently of dermal leishmaniasis in man. It would, however, be likely to favour *P. papatasi* (Scop.) which breeds and probably rests in deep soil cracks.

DOW (R. P.), BIGHAM (J. T.) & SABROSKY (C. W.). **Sequel to "*Hippelates* (Eye Gnat) Investigations in the southeastern States" by John T. Bigham (Diptera, Chloropidae).**—*Proc. ent. Soc. Wash.* **53** no. 5 pp. 263–271, 2 refs. Washington, D. C., 1951.

Over 40,000 Chloropids collected by Bigham during his investigations on *Hippelates pusio* Lw. in 1937–39 [*R.A.E.*, B **30** 59] were subsequently studied by Sabrosky and found to include about 20 per cent. of a species that he described in a paper already noticed [**29** 144] as *H. bishoppi*. A fresh analysis of the data showed that Bigham's conclusions regarding *H. pusio* were not vitiated by the inclusion of so large a proportion of a previously unrecognised species and that *H. bishoppi* also breeds in cultivated or otherwise disturbed soil. Data are given on 17 hand collections, 16 of which involved only or almost only *H. pusio*. They were mostly made on cattle with conjunctivitis, or on cattle, horses or other animals with skin disease, wounds or sores. *H. bishoppi* was absent from them all.

Krusé (C. W.), Ludvik (G. F.) & Hawkins (W. B.). **Factors affecting Evaluation of Insecticides against** *Anopheles* **Larvae.**—*J. econ. Ent.* **45** no. 4 pp. 598–601, 4 graphs, 8 refs. Menasha, Wis., 1952.

Data are given illustrating the wide standard deviations obtained in the results of experiments in which *Anopheles* larvae are tested in graded series of DDT alcohol-water suspensions. Variations in results are brought about by seemingly small changes in technique, such as exposing equal numbers of larvae in smaller or larger volumes of a given concentration, or by changing the numbers of larvae used per replicate.

When DDT was applied to the surface of water as a film in oil, mortality from a given dose of DDT was reduced from 80 to 1·5 per cent. by increasing the number of larvae used. Crowding had little effect on mortality among controls.

The instability of alcohol-water suspensions was shown by the fact that mortality in series of larvae decreased with an increase in time between the filling of the container and the introduction of the larvae. The percentages of DDT lost from suspensions in paper cartons and in glass and enamelled containers, respectively, were 25 in two, nine and nine hours and 76, 43 and 40 in 24 hours. Emulsified solutions, however, were completely stable for 48 hours in glass and enamelled containers, and had lost only 21 per cent. of their DDT after 24 and 48 hours in paper cartons.

Brown (A. W. A.). **Rotary Brush Units for aerial Spraying against Mosquitoes and Black Flies.**—*J. econ. Ent.* **45** no. 4 pp. 620–625, 2 figs., 5 refs. Menasha, Wis., 1952.

The following is based on the author's introduction and summary. Although a straight emission pipe, with or without an air-scoop, is satisfactory for applying mosquito larvicides from aircraft, it gives too coarse a droplet spectrum to be economical for sprays against adult mosquitos. The spectra obtained with DDT in polymethylnaphthalenes and fuel oil showed mass median diameters between 300 and 400 μ and some droplets more than 500 μ in diameter. The possibility was therefore examined of using an apparatus that could be fitted on to the straight emission pipe and give sufficiently thorough atomisation to avoid the production of coarse droplets. Such an apparatus is provided by a sheaf of rotary brushes driven by an outboard propeller, models of which are obtainable commercially.

A rotary brush unit was tested on a Dakota DC3 (C-47) aircraft for its suitability for applying sprays against *Aëdes* adults in subarctic spruce forest in Canada. The unit was mounted below the fuselage and supplied by gravity feed through a vertical discharge pipe. With a five-brush assembly on the unit, the droplet spectrum obtained with 10 per cent. DDT in trimethylnaphthalene and fuel oil emitted at 1·05 gal. per second when the aeroplane was flying at 150 miles per hour showed a mass median diameter of 195 μ. With a three-brush assembly emitting spray at 0·58 gal. per second, the mass median diameter was 180 μ. No droplets were more than 315 μ in diameter.

Spraying runs were made 300 yards apart and at a height of 100 ft. When 10 square miles were treated with 10 per cent. DDT dispersed by the five-brush assembly, giving 0·22 lb. DDT per acre, an average reduction of 98·7 per cent. in the population of adult mosquitos was obtained ; the average reduction of Simuliids was not less than 80 per cent. and probably considerably more. When 5 per cent. DDT was dispersed by the five-brush assembly over a similar area, giving 0·11 lb. DDT per acre, the average reduction was 87·4 per cent. for mosquitos and only 24 per cent. for Simuliids. When 20 per cent. DDT was

dispersed by the three-brush assembly, giving 0·27 lb. per acre, the average reduction of mosquitos was 96·5 per cent. and of Simuliids 87 per cent.

The use of the rotary brush, in addition to improving control of adult mosquitos to an average of 99 as compared with 85 per cent., greatly economises flying time through an increase of swath width from 200 to 300 yards and of spray concentration from 4 to 10 per cent., allowing 3·4 sq. miles instead of 1 sq. mile to be covered per flight. Moreover, application can be made from a height of 100 ft. at nearly all wind speeds. The flying height needs to be increased only when the cross-wind component falls below 4 m.p.h.

MOORE III (S.) & SWEETMAN (H. L.). **Laboratory and Field Tests with vaporized Lindane against four Species of Roaches.**—*J. econ. Ent.* **45** no. 4 pp. 655–657, 7 refs. Menasha, Wis., 1952.

The effectiveness of vaporising γ BHC as lindane at 1·6–3·5 gm. per 20,000 cu. ft. per day was observed on cockroaches of three species kept in cages for 14, 20 or 27 days at distances up to 50 feet from the point of liberation. The mortality percentages after exposure for 14, 20 and 27 days were 92·5, 100 and 100 for *Blattella germanica* (L.), 72·5, 57·5 and 87·5 for *Periplaneta americana* (L.) and 0, 50 and 52·5 for *P. australasiae* (F.). Females of *Blattella* and males of the other species were more susceptible to the treatment than the opposite sex. No mortality due to treatment occurred in survivors during the 14 days following exposure. No difference in the rate of mortality caused by the various dosages or at different distances from the vaporiser was apparent. Females of all species deposited egg cases during the exposure.

Lindane was tested as a vapour and as a spray from hand pressure sprayers against natural infestations of *B. germanica* and *Blatta orientalis* (L.) in Massachusetts. A 2 per cent. chlordane emulsion spray was used for comparison against *Blattella germanica* and proved more effective than lindane. Neither substance appeared to be repellent. Continuous vaporisation of lindane at recommended rates was slow in overcoming infestations of both species. The value of vaporised lindane against them would appear to lie chiefly in the possibility of simultaneous control of other household pests [*cf. R.A.E.*, A **40** 85, 122]. Chlordane spray or dust treatments are recommended for the rapid eradication of cockroaches.

SCHOOF (H. F.), SIVERLY (R. E.) & JENSEN (J. A.). **House Fly Dispersion Studies in Metropolitan Areas.**—*J. econ. Ent.* **45** no. 4 pp. 675–683, 2 figs., 5 refs. Menasha, Wis., 1952.

In studies of the dispersal range of flies, principally *Musca domestica* L., made at Phoenix, Arizona, in 1951, 31,000 flies marked with radioactive phosphorus were released in June and 56,000 in September. Catches made subsequently from baited traps distributed over the metropolitan area in concentric rings or segments included 227 and 284 marked flies, of which 88 and 81 per cent., respectively, were found within a mile of the place of release. The proportion of radioactive flies in the catches varied inversely with the distance from the place of release, except that more were taken at one mile than 0·5 mile in June and about equal numbers in September. Some flies travelled a mile within 24 hours, three miles within 48 hours and four miles within 72 hours. The numbers of marked flies collected three, four and five miles from the release points were small, but the fact that 10·1 per cent. of the marked flies recovered in June–July and 13 per cent. of those recovered in September–October were taken two miles from the release point indicates that movement to this distance may be of practical importance.

The chief factor governing the pattern of dispersal was the attractiveness of an area. In the June tests, in which trap sites were distributed more or less regularly, 77 per cent. of the marked flies were taken at seven of the 50 stations, and 108 of the 120 marked flies collected from the 12 stations on the one-mile ring and more than 62 per cent. of the total flies trapped were at two adjacent stations. In the September test, trap stations were chosen on the basis of apparent equal attractiveness, and catches of marked flies were much more evenly distributed among them. The data indicated that if stimuli of equal attractiveness surround a given point, dispersion is likely to be random, but where attractiveness is unequal, movement is concentrated along paths of attractiveness radiating from the release site.

The importance to a community of an area of high fly production situated a mile or more away from it depends on the sources of attraction in the intervening zone. Although an attractive intervening area favours movement towards the town, the reciprocal migration that apparently takes place between attractive sites within the intermediate zone may largely dissipate the effect of infiltration. In view of the influence of attractants on the infiltration of *M. domestica* into an area, removal of these substances is as important a part of a community fly control programme as the elimination of breeding media.

Portman (R. F.) & Williams (A. H.). **Control of Mosquito Larvae and other Pests in Rice Fields by DDT.**—*J. econ. Ent.* **45** no. 4 pp. 712–716, 3 refs. Menasha, Wis., 1952.

An account is given of extensive tests made in rice-fields in the Sacramento Valley of California in spring 1950 on the use of DDT for the simultaneous control of larvae of *Aëdes dorsalis* (Mg.) and of fairy shrimps of the genus *Apus* and larvae of the water beetle, *Hydrous triangularis* (Say), both of which are very injurious to the rice seedlings. *Aëdes dorsalis* has been a serious pest in the area for several years. The DDT was applied before flooding, with the seed rice at sowing, or when the pests were already present. When the dry cultivated soil was sprayed with an emulsified xylene solution of DDT at 1–4 lb. DDT per acre or a wettable-powder suspension at 4 lb. per acre and flooded within nine days, the water remained lethal to caged fairy shrimps for at least two weeks, *Aëdes* and *Hydrous* larvae were effectively controlled and the fields were not infested by other mosquito larvae for about a month. This method is applicable where dry rice seed is broadcast with ground equipment before the fields are flooded. After 3,900 acres of rice-fields had been treated with DDT at 1–4 lb. per acre by mixing a wettable powder with the damp rice seed applied from aircraft, no infestation by *Apus* occurred, though many of the fields had been heavily infested in previous years, no larvae of *Aëdes dorsalis* or other mosquitos appeared for about a month and the *Hydrous* larvae were effectively controlled in the individual fields observed. In 1951, many rice growers applied wettable-powder DDT with their seed, and no damage by *Hydrous* larvae or *Apus* occurred in about 60,000 acres so treated, while trouble from *Aëdes dorsalis* was greatly reduced. This is an effective and economical method of control, where sowing is done from aircraft. Spraying of infested fields with DDT in emulsified xylene solution at 8–16 oz. DDT per acre killed *Apus*, *Hydrous* larvae and mosquito larvae in 20 hours. This method is also very effective against the adult beetles.

Dicke (R. J.), Moore (G. D.) & Hilsenhoff (W. L.). **House Fly Response to volatilized Chlorinated Hydrocarbon Insecticides.**—*J. econ. Ent.* **45** no. 4 pp. 722–725. Menasha, Wis., 1952.

Cage experiments in which flies [*Musca domestica* L.] were allowed a choice of treated or untreated surface showed that panels treated with water suspensions

of DDT or methoxy-DDT (methoxychlor) were much more toxic than panels treated with water suspensions of BHC, chlordane or DDD, and that deposits from such suspensions were appreciably more toxic than those from kerosene solutions. Field experiments in Wisconsin generally confirmed these results, and it was assumed that test procedures that enclose insects or confine them to treated surfaces do not differentiate between contact toxicity and fumigation from volatile insecticides or take account of the attractiveness or repellence of a deposit. The relatively poor control obtained in the field with water suspensions of BHC, chlordane and DDD and kerosene solutions of DDT, methoxy-DDT and chlordane appeared to be due to repellence, while fumigation effect was relatively negligible in the open.

The responses of the flies to the vapours from a series of chlorinated-hydrocarbon insecticides were therefore tested in a Y-tube olfactometer, which is described. The technical grade of each compound and a proprietary wettable powder containing it were used. The results indicated that methoxy-DDT and DDT were significantly attractive. Dieldrin and the technical grade of DDD were neutral in effect. Heptachlor, toxaphene, fluoro-DDT (DFDT), the wettable powder of DDD, aldrin, γ BHC as lindane, BHC and chlordane were all significantly repellent to a degree ranging from moderate in the case of heptachlor and toxaphene to extreme in that of BHC and chlordane. The wettable powders of DDD and aldrin were significantly more repellent than the technical grades, indicating either that these preparations were more volatile or that adjuncts with a repellent effect were used in their formulation. Kerosene was extremely repellent and appears to be a poor solvent for use in sprays intended to leave an insecticidal deposit. Heptachlor, BHC and lindane all had a considerable fumigation effect. The wettable powders of BHC and lindane were apparently more volatile than the unprocessed technical grade. The other substances showed little or no fumigant effect. There appears to be no correlation between repellence and toxicity of vapour, since neither the very repellent chlordane and kerosene nor the relatively attractive methoxy-DDT and DDT had any marked fumigant action.

Schoof (H. F.). **The attached Bait Pan Fly Trap.**—*J. econ. Ent.* **45** no. 4 pp. 735–736, 1 fig., 3 refs. Menasha, Wis., 1952.

An improved trap for evaluating populations of *Musca domestica* L. and blowflies is described ; it consists of a cage and bait pan attached to a metal standard. The cage, which is 6·125 ins. in diameter and 8·125 ins. high, has a removable screened lid and a built-in entrance cone at the bottom and is made to fit closely over the upper rim of the bait pan, which is 4·5 ins. high and is provided at the middle with a 1·5 in. rib of hardware cloth to admit the flies. The metal standard is of angle iron and is about 2 ft. long. It is fitted with a curved handle of strap iron. Two sections of angle iron welded to the standard, one at the top and one halfway up, serve as a hand support and footrest for forcing the standard into the ground. The cage and pan are fastened to the standard with stove bolts. In operation, a carton containing suitable bait is placed in the pan, which is then inserted into the open bottom of the cage, after which the two are attached as a unit to the standard and the trap is suspended from a fence or branch of a tree or the standard is driven into the ground. From comparative tests and field use over two seasons, it appears that the trap is satisfactory for the qualitative sampling of populations. Its advantages over the types previously used in the United States are that it is cheaper, it needs less bait, it is smaller and can be easily dismantled, thereby facilitating transport, the killing and removal of specimens and storage, and it can be hung from fences or trees, thereby increasing the number and types of situations from which samples can be taken.

Brown (J. H.). **Tick Paralysis : a Note on a Human Case caused by a Male Tick.**—*J. econ. Ent.* **45** no. 4 pp. 737–738. Menasha, Wis., 1952.

An account is given of a mild case of paralysis that occurred in a man in Alberta in June 1940 and appeared to be the result of feeding by a male of *Dermacentor andersoni* Stiles, which was found attached to the axilla about 36 hours after the onset of symptoms.

McGregor (W. S.), Smith (C. L.) & Richards (R.). **Comparison of high and low Spray Pressures for Control of Cattle Grubs.**—*J. econ. Ent.* **45** no. 4 p. 740, 5 refs. Menasha, Wis., 1952.

Sprays containing 7·5 lb. cubé or derris (5 per cent. rotenone) per 100 U.S. gals. applied at pressures of 200 and 400 lb. per square inch were compared in 1950 and 1951 in Texas for the control of *Hypoderma lineatum* (Vill.) on 12 herds of heavily infested cattle. Part of each herd was sprayed at each pressure. Second-stage and third-stage larvae squeezed from the cysts a week after treatment were examined for mortality. The results for each herd are given. Mortality among the larvae recovered varied in the two groups of animals, but the ranges (52–90 and 64–89 per cent.) were similar and the average (76 per cent.) was identical for both. It appears that spraying with derris or cubé will give only partial kill of the larvae present in the backs of the animals at the time of application regardless of the pressure used [*cf. R.A.E.*, B **34** 97 ; **39** 180, etc.].

Fales (J. H.), Bodenstein (O. F.) & Piquett (P. G.). **Effectiveness of Allethrin and Pyrethrins as Sprays against three Species of Mosquitoes.**—*J. econ. Ent.* **45** no. 4 pp. 743–744, 3 refs. Menasha, Wis., 1952.

Allethrin was compared with pyrethrins at various concentrations in sprays against free-flying, laboratory-reared adults of *Aëdes aegypti* (L.), *Anopheles quadrimaculatus* Say and *Culex pipiens* L. in a Peet-Grady chamber. The mosquitos were liberated in the chamber before the spray was released. There were up to seven replicates with about 80 mosquitos per test. The *Aëdes* were exposed for five minutes and collected after ten more minutes, during which time the chamber was being ventilated ; the other species were exposed for ten minutes and collected immediately after exposure. The results of the experiments are given in a table. Females were much more resistant than males. In the case of females, the median lethal concentration of allethrin was eight times that of pyrethrins for *Aëdes*, twice for *Anopheles* and about 5·5 times for *Culex*. In the case of males, the median lethal concentration of allethrin was again eight times that of pyrethrins for *Aëdes*, but the two were about equal in performance against *Anopheles* ; against *Culex*, the lowest concentration of allethrin tried (3·2 mg. per ml.) gave about the same results as the highest concentration of pyrethrins (1·6 mg. per ml.). *Aëdes* was the least resistant of the three mosquitos and *Culex* the most.

McGregor (W. S.) & Schomberg (O. C.). **A partial annotated List of Species of the Tabanidae.**—*J. econ. Ent.* **45** no. 4 p. 746, 2 refs. Menasha, Wis., 1952.

Severe outbreaks of Tabanids have occurred in certain areas of Texas for many years, and the extent of these areas has recently increased. It has been reported that Tabanids are directly responsible for more than half the losses in the cattle of the Texas coastal region. During severe outbreaks, there

may be 100–200 flies belonging to as many as ten species on one animal. A list is given of 40 species (three of them represented by two subspecies) collected in the spring of 1950 in areas subject to heavy infestation, mainly in the eastern part of the State.

SCHOMBERG (O. [C.]). **Larval Habitat of** *Tabanus sulcifrons* **in Oklahoma.**— *J. econ. Ent.* **45** no. 4 p. 747, 2 refs. Menasha, Wis., 1952.

Tabanus sulcifrons Macq. is one of the most numerous Tabanids of Oklahoma. Adult emergence begins late in June and reaches a peak in August, and populations decline in September. To obtain data on larval habitats, extensive series of soil samples were taken in 1949, 1950 and 1951 in the Stillwater area, where the species is abundant. Originally, samples were taken to a depth of 6 ins., but as larvae were found to occur near the surface, later ones were to a depth of 3 ins. only. The larvae collected were reared individually in damp sand and fed twice weekly on Annelids, and identifications were made on the basis of the adults until experience enabled the larvae to be easily recognised. Thousands of samples from wet areas yielded only one larva of *T. sulcifrons*, but 255 were found in 37 situations in well-drained areas, mostly in wooded gullies, that apparently received moisture only from rainfall. The maximum number found in one square yard was 4, but the average population in favourable sites was 2–3 per square yard. The larvae were generally 0·5–1·5 ins. below the surface and never more than 2 ins. Aestivation occurred in short tunnels in the dry soil. Larvae ranging in size from very small to full-grown were sometimes found at one site, and full-grown larvae were found in every month, though they were most abundant in May–June. Most of the larvae brought into the laboratory gave rise to adults within a year, but some took longer. The larvae will apparently feed in winter whenever the soil temperatures become high enough for activity. Three pupae were found in a situation in which larvae were collected. One was lying horizontally very near the surface and the others vertically with the anterior end nearly exposed.

SMITH (C. L.). **Field Tests of Insecticides against Ectoparasites of Poultry.**— *J. econ. Ent.* **45** no. 4 pp. 748–749. Menasha, Wis., 1952.

Data on the results of field tests on the effectiveness of various chlorinated hydrocarbons against *Menacanthus* (*Eomenacanthus*) *stramineus* (Nitzsch), *Dermanyssus gallinae* (Deg.) and *Argas persicus* (Oken) on fowls in Texas, are tabulated and discussed. The insecticides tested had shown promise for the control of *A. persicus* in laboratory trials. They were applied in poultry houses as sprays to the walls, roosts and floor at about 5 U.S. gals. per house (12×12×7 ft.) and at a pressure of 100–150 lb. per sq. inch, as a paint to roosts, as a dust to the flock as a whole with a hand rotary-type duster or to the nests or as a mist over the fowls. Mortalities of the louse were determined by examining 25 birds at random ; for the mite and the tick, the roosts and other hiding places were examined. Counts were usually made one, two and seven days after treatment, and thereafter occasionally for 4–6 months. Lindane [γ BHC] gave good control of the louse when used as a roost paint at a concentration of 1 per cent. or more, as a mist at 500 cc. and 0·5 per cent. concentration and as a spray at 0·5 per cent., and of the mite and tick as sprays at 0·25 and 0·2 per cent., respectively. As a 1 per cent. dust, it killed larvae of the tick in 24 hours. Chlordane gave good control of the louse as a 2 per cent. spray with a deposit of 2·5 gm. per sq. ft. and of the tick as a 0·5 per cent. spray. DDT gave good control of the louse as a 10 per cent. dust at 0·6 oz. per bird and of the mite as a 5 per cent. spray. Toxaphene and aldrin gave good control of the tick

as sprays at 0·5 and 0·25 per cent., respectively. Lindane did not possess the lasting qualities against the tick shown by chlordane and toxaphene. A dust containing 1 per cent. p,p'methoxy-DDT (methoxychlor) applied to the fowls at an average rate of 0·6 oz. dust per bird failed to control the lice, and DDT, toxaphene and chlordane dusts containing 5 per cent. active ingredient gave very poor control of the mite when applied to the nest at 0·7 oz. dust per nest. Toxaphene and chlordane were also poor against it as sprays. Dieldrin, which was tested as a spray against the tick at 0·05 and 0·1 per cent., is stated to have shown promise. Throughout the tests, no difference was noticed between the effectiveness of a spray made from an emulsion concentrate and one made from a wettable powder. The importance of using well-built modern fowl houses in obtaining good control, particularly of the mite and the tick, is stressed.

WALL jr. (W. J.) & BAILEY (S. F.). **Repellency of Cotton Tufts to Flies.**—*J. econ. Ent.* **45** no. 4 pp. 749–750. Menasha, Wis., 1952.

As housewives in various parts of the United States place tufts of white cotton-wool on window and door screens to repel flies, the effectiveness of the method was tested in 1951. The screens used were 2 ft. square and were set up in a cow barn where *Musca domestica* L. was very abundant. A cotton-wool ball, 4 ins. in diameter with flat or fluffed surface, or a 12-inch square of cotton-wool was placed in the centre of a test screen or 16 small tufts were scattered at regular intervals over it, and a similar screen was used as a control. Finally, a loose ball of cotton 1·5 ins. in diameter was suspended in front of a 12-inch circle marked on a wall. Flies alighting on the screens and fly specks appearing on the wall and on a similar control patch in six weeks were counted.

It is concluded from the results that the flies will alight on cotton-wool though they prefer a more solid surface, they are not significantly repelled by a small ball of cotton-wool and there is no significant difference between the repellency of a tight ball or a loose one. A suspended ball repelled a significant number of flies when it was swinging in a breeze but not when it was stationary.

MATSUI (M.), LAFORGE (F. B.), GREEN (N.) & SCHECHTER (M. S.). **Furethrin.**—*J. Amer. chem. Soc.* **74** pp. 2181–2182, 14 refs. Easton, Pa., 1952.

The preparation of furethrin, a mixture of stereoisomeric insecticidal esters of the type of pyrethrin I, but with a 2-furfuryl side chain [*cf. R.A.E.*, B **38** 103], is described. Furfurylacetone was obtained by hydrogenation of furfuralacetone, and the necessary cyclopentenolone, 2-(2-furfuryl)-4-hydroxy-3-methyl-2-cyclopenten-1-one (for which the name furethrolone is proposed) was prepared from it and acylated with a mixture of acid chlorides of *dl-cis*- and *dl-trans*-chrysanthemum monocarboxylic acids to form furethrin. The procedures followed those employed in the synthesis of allethrin [the completely synthetic allyl homologue of cinerin I (*cf. loc. cit.*)].

In tests on house-flies [*Musca domestica* L.], furethrin proved to be about equal to pyrethrins in toxicity. Its production might be more economical than that of allethrin, owing to the low cost and ready availability of furfuralacetone.

GJULLIN (C. M.) & PETERS (R. F.). **Recent Studies of Mosquito Resistance to Insecticides in California.**—*Mosquito News* **12** no. 1 pp. 1-7, 5 refs. Albany, N. Y., 1952.

The following is almost entirely based on the authors' introduction and summary. The larvicides used for mosquito control in the San Joaquin Valley

of California were DDT in 1946–51 and toxaphene and, to a less extent, various grades of BHC in and after 1949. Larvae resistant to DDT were first reported in 1949, and all three larvicides (including γ BHC as lindane) failed to give control in some areas in 1950–51. In 1951, larvae of some important species were collected from breeding places in six counties that had or had not been treated and the differences in toxicity of various larvicides to them were compared in the laboratory. The criterion was the median lethal concentration in acetone-water suspension.

Larvae of *Aëdes nigromaculis* (Ludl.) from the treated areas were found to be 3–7 times as resistant to DDT as larvae from the untreated areas. They were less than twice as resistant to toxaphene, except in two areas in which they were 2–3 times as resistant. They showed little or no resistance to lindane or aldrin except in one area where they were twice as resistant to both. In a few tests with *A. dorsalis* (Mg.), resistance to DDT was 3–12 times that of larvae from the untreated area, but no resistance to the other insecticides was evident.

Larvae of *Culex tarsalis* Coq. from a duck club in the Kern District where toxaphene and aldrin were failing to give control, were found to be 10, 33, 11, 215 and 1,300 times as resistant, respectively, to DDT, toxaphene, lindane, aldrin and heptachlor as larvae from an untreated area. Heptachlor and lindane had not been used in the area. Larvae from another duck club nearby which had received the same treatments showed much lower resistance. Parathion was about equally toxic to both treated and untreated larvae. DDT at 1 lb. per acre was effective against these larvae in the first application after the tests and failed in the second. Dieldrin was ineffective at 1·5 lb. per acre.

Papers noticed by Title only.

Claborn (H. V.) & Beckman (H. F.). **Determination of 1,1,1-Trichloro-2, 2-bis(p-methoxyphenyl)ethane** [p,p'methoxy-DDT] **in Milk and Fatty Materials.**—*Analyt. Chem.* **24** no. 1 pp. 220–222, 7 refs. Easton, Pa., 1952.

Hoskins (W. M.), Witt (J. M.) & Erwin (W. R.). **Bioassay of 1,2,3,4,5,6-Hexachlorocyclohexane (Lindane). Some Factors influencing the Contact of Chemical and Test Insect and Methods for standardizing the Process.**—*Analyt. Chem.* **24** no. 3 pp. 555–560, 2 graphs, 3 refs. Easton, Pa., 1952. [See *R.A.E.*, A **41** 70.]

Bowen (C. V.). **Report on Benzene Hexachloride** [list of methods recommended for determining γ isomer in technical BHC and BHC formulations].—*J. Ass. off. agric. Chem.* **34** no. 3 p. 689. Washington, D.C., 1951. [*Cf. R.A.E.*, B **39** 112.]

Hornstein (I.). **Report on Benzene Hexachloride** [methods of determination of total BHC and of γ BHC in lindane].—*J. Ass. off. agric. Chem.* **35** no. 2 pp. 366–368, 3 refs. Washington, D.C., 1952.

Edwards (F. I.). **Report on Parathion** [methods of determination].—*J. Ass. off. agric. Chem.* **35** no. 2 pp. 381–386, 5 refs. Washington, D.C., 1952. [*Cf. R.A.E.*, B **40** 120.]

Buck (J. B.), Keister (M. L.) & Posner (I.). **Physiological Effects of DDT on *Phormia* Larvae.**—*Ann. ent. Soc. Amer.* **45** no. 3 pp. 369–384, 9 figs., 17 refs. Columbus, Ohio, 1952.

The following is virtually the authors' summary. DDT is toxic to larvae of *Phormia regina* (Mg.) in doses of the same order as those toxic to adult insects when introduced as an oil solution into the blood or tracheal system. It is also toxic, after considerable delay, if introduced intratracheally in aqueous suspension. It has little if any toxicity when ingested as crystals or in olive-oil solution. The larval skin of *P. regina* is impervious to DDT, either alone or in solution. In larvae showing symptoms of poisoning, DDT enhances oxygen uptake, water loss under dry conditions, and water gain under wet conditions. Oxygen uptake in dry conditions is not significantly different from that in wet conditions in either control or poisoned larvae. There are some indications that DDT reduces the hydrophobic properties of the posterior spiracles. DDT has no apparent effect on cutaneous permeability to water. The respiratory quotient rises from 0·74 to 0·84 in DDT poisoning. Oxygen uptake of poisoned larvae is markedly decreased by ligating behind the brain, indicating that the high uptake characteristic of DDT poisoning is due to neuromuscular activity. Some direct stimulation of peripheral nerves may be involved in addition to that mediated by the central nervous system.

Horsfall (W. R.) & Morris (A. P.). **Surface Conditions limiting larval Sites of certain Marsh Mosquitoes.**—*Ann. ent. Soc. Amer.* **45** no. 3 pp. 492–498, 1 fig., 3 refs. Columbus, Ohio, 1952.

The following is virtually the authors' summary. The relative effects of shade, surface vegetation and mean maximum temperature of the surface water on the minute distribution of larvae of four common mosquitos were determined for a shallow marsh in central Illinois. A combination of a summer mean-maximum water temperature of 24–25°C. [75·2–77°F.] and a surface vegetation of duck-weed [? *Lemna minor*] provided sites of greatest larval abundance for *Uranotaenia sapphirina* (O.-S.) and *Culex apicalis* Adams. *Anopheles quadrimaculatus* Say was more abundant in the warmer water broken by waterweed [*Elodea canadensis*] and shaded by a canopy. *A. punctipennis* (Say) was far more commonly collected in areas where the mean maximum temperature of the water was 18°C. [64·4°F.], with little regard for surface vegetation or shade. Chronologically, peak populations of larvae occurred as follows: first, *C. apicalis*, second, *U. sapphirina*, third, *A. quadrimaculatus* and fourth, *A. punctipennis*.

Chow (C. Y.). **The Identification and Distribution of Chinese Anopheline Mosquitoes.**—*J. nat. Malar. Soc.* **8** no. 2 pp. 121–131, 17 refs. Columbia, S.C., 1949.

Data are given on the distribution in China (including Formosa) of the 38 species and varieties of *Anopheles* known to occur there, together with keys to the females of 37 of them and to the larvae of 36, and notes on the breeding places of nearly all and the adult habits and relation to malaria of a few.

Grenier (P.). **Simuliidae de l'est congolais (description des nymphes et imagos ♂ et ♀ de : *S. neavei* Roub. (?) et *S. marlieri* n. sp.).**—*Bull. Soc. Path. exot.* **43** no. 1–2 pp. 92–100, 2 figs., 16 refs. Paris, 1950.

The pupae and adults of both sexes of *Simulium marlieri*, sp.n., and a species tentatively identified as *S. neavei* Roub. are described from material collected in the eastern Belgian Congo in June 1949. The pupae of both species

(453) Wt. P9/3884 6/53 S.E.R. Ltd. Gp. 432 [B] A

were obtained from a fast-flowing stream at an altitude of about 6,600 ft., and the adults were reared or dissected from them. The pupae of the species identified as *S. neavei* have ten respiratory filaments [whereas the pupa of *S. neavei* described by McMahon (*R.A.E.*, B **40** 5) had eight]. Its identification is based on a comparison of the anatomical characters of a female that emerged from one of the pupae with those of a paratype of *S. neavei* from the collection of the Pasteur Institute, which the author dissected and mounted on a slide, and is considered tentative on account of the poor condition of the Congo female.

Bell (D. S.), Pounden (W. D.), Edgington (B. H.) & Bentley (O. G.). *Psorergates ovis*—**a Cause of Itchiness in Sheep.**—*J. Amer. vet. med. Ass.* **120** no. 900 pp. 117–120, 5 figs., 5 refs. Chicago, Ill., 1952.

In 1951, some of the sheep in a flock of merino ewes born and raised in Ohio were observed to be suffering from an irritation, not associated with infestation by any recognised ectoparasite, that caused them occasionally to scratch, rub, and bite at the wool, producing a taggy appearance, and otherwise to show signs of mild unrest. Examination of deep skin scrapings and skin clippings and shavings revealed the presence of minute mites which were identified, on the basis of morphological characteristics and the damage caused, as *Psorergates ovis* Womersley [*cf. R.A.E.*, B **30** 140 ; **31** 249 ; **39** 52 etc.]. This is apparently the first record of the mite in North America.

Wharton (G. W.) & Fuller (H. S.). **A Manual of the Chiggers. The Biology, Classification, Distribution, and Importance to Man of the Larvae of the Family Trombiculidae (Acarina).**—*Mem. ent. Soc. Wash.* no. 4, $10\frac{1}{4} \times 6\frac{3}{4}$ ins., [8+] 185 pp., 17 figs., 23 pp. refs. Washington, D.C., 1952. Price $6.

The information on which this monograph is based has largely been drawn from the literature, but the results of certain original investigations that supplement previously existing knowledge are included. Introductory sections on the relationship of Trombiculid larvae to tsutsugamushi disease and to dermatitis in man, domestic animals and poultry and on the control of these larvae, and somewhat fuller information on their anatomy and bionomics (with notes on those of the subsequent stages of the life-cycle) precede the main section of the book (pp. 40–105), which deals with classification. This comprises keys to subfamilies, genera and subgenera, definitions of them, and lists of the species ; the full synonymy of each species is given, with references to the literature on it (in which the types of information in the individual papers are indicated) and records of its distribution and hosts. There are also a faunal list showing the species known from various countries, a list of hosts showing the species found on each, and notes on collecting and culture methods and on seasonal, diurnal and ecological distribution.

Kaul (S.). **Relapsing Fever—Tick-borne. Account of an Outbreak in J. & K. Force, India.**—*Indian med. Gaz.* **84** no. 10 pp. 433–440, 1 pl., 4 graphs, 9 refs. Calcutta, 1949.

About 100 cases of relapsing fever occurred in February–June 1948 among Indian troops on service in Jammu Province and the Kashmir Valley ; most of the men concerned had been bitten by ticks while occupying huts or shelters built of materials from huts previously occupied by raiders from the North-West Frontier Province. Details are given of the course of the disease in the 52 cases in which a diagnosis of tick-borne relapsing fever was supported both by a history of tick bites and by the finding of spirochaetes in smears. It is thought that the disease, which is not known to have been previously recorded

in India, had been introduced from the tribal territory of the North-West Frontier, where cases have been said to occur. A further six cases of relapsing fever, indistinguishable in clinical features from the series discussed, occurred in men who did not show the tick-bite marks typical of the other cases and gave a history of having been bitten by bugs or fleas. They had not apparently been infested by lice at any time.

[Piontkovskaya (S. P.).] **Пионтковская (С. П.). The Ticks *Hyalomma marginatum marginatum* Koch as Carriers of Rickettsiae.** [*In Russian.*]—*Zool. Zh.* **28** pt. 5 pp. 419–420, 1 pl., 2 refs. Moscow, 1949.

Successive generations of *Hyalomma marginatum marginatum* Koch were reared from some of the ticks in which rickettsiae had been found in the Crimea [*R.A.E.*, B **41** 18–19]. Examination of smears of the digestive and sexual organs of seven of the reared males and 38 of the females revealed the presence of polymorphic rickettsiae in the salivary glands, stomach, Malpighian tubes or ovaries of seven of the females. These females belonged to the second and third laboratory generations and comprised descendants of three of the original batches from the steppe zone and one of those from the mountain-forest zone.

Irons (J. V.), Eads (R. B.), Johnson (C. W.), Walker (O. L.) & Norris (M. A.). **Southwest Texas Q Fever Studies.**—*J. Parasit.* **38** no. 1 pp. 1–5, 6 refs. Lancaster, Pa., 1952.

A list is given of wild and domestic animals examined in an area of south-western Texas between 1st March 1950 and 28th February 1951 and of the ectoparasites (ticks, mites, lice and fleas) found on each of the 28 species in a survey designed to demonstrate the part, if any, played by arthropods in the maintenance and spread of Q fever. The disease is prevalent in the area. The 9,320 ectoparasites, which belonged to 34 species, were pooled by species and inoculated into laboratory animals, and all were found to be negative for Q fever, though more recently an over-all pool was positive.

Serological examination of the blood of the hosts showed complement-fixing titres in sera of the pack rat (*Neotoma micropus*). Ticks (*Ornithodoros talaje* (Guér.)) allowed to feed on experimentally infected pack rats acquired the infection between six and 11 days after inoculation of the rodents. The milk of two cows from which several negative pools of *Otobius megnini* (Dugès) were collected was repeatedly found to be infected, but no infection could be demonstrated in field-collected examples of *Amblyomma americanum* (L.) that had been allowed to engorge on these cows or their calves.

Scott (J. A.). **A Humidity Chamber for maintaining the Tropical Rat Mite, *Bdellonyssus bacoti*.**—*J. Parasit.* **38** no. 1 pp. 90–91, 1 fig. Lancaster, Pa., 1952.

To maintain *Bdellonyssus bacoti* (Hirst) from the time the mites are fed on cotton rats [*Sigmodon hispidus*] infected with *Litomosoides carinii* until the filarial larvae have reached the infective stage requires careful regulation of temperature and humidity. An apparatus is described which, when kept at a controlled temperature of 22–26°C. [71·6–78·8°F.], provides the necessary high humidity without the formation of dew. The base consists of a wide-mouthed bottle containing a little water or a moist layer of plaster of paris and powdered charcoal. The mites are placed in a pyrex glass tube, the bottom of which is covered with bolting silk retained by a rubber band over which a ring of thick rubber tubing is slipped to form a stopper to the base jar. The mites can be drawn into the tube by applying suction through the silk after

fitting the top with a rubber stopper pierced by a glass tube with a narrow tip. When they have been shaken down, the stopper is replaced by a sheet of pliofilm held by a rubber band.

PETERSON (D. G.). **Observations on the Biology and Control of Pest Trichoptera at Fort Erie, Ontario.**—*Canad. Ent.* **84** no. 4 pp. 103–107, 1 map, 7 refs. Ottawa, 1952.

Fort Erie, Ontario, and the waterfront zone of Buffalo, New York, which are on opposite banks of the Niagara River, are annually infested by large numbers of Trichoptera and to a smaller extent, Ephemeroptera. An investigation of the infestations and possible means of controlling them was made at Fort Erie in August 1950. Data are given on the dense swarms seen during the survey [*cf. R.A.E.*, B **39** 163]. These extended for 1,000 yards from the river and about 300 ft. upwards and were present for a few hours before and after sunset. The annoyance caused includes prevention of all exterior decorating during summer, the filth and stench of the masses of dead insects that accumulate under street lamps and other sources of illumination, the caution needed when driving during the evening flight, and the allergic reaction suffered by hypersensitive individuals. A preliminary survey indicated that breeding takes place under the rapid water of the river opposite the built-up area. The species composition is discussed.

Control of the larvae is considered undesirable in view of the importance of the Trichoptera in the biological balance in the river, but the possibility of controlling the adults was investigated, as it was unlikely that this would reduce the numbers of the immature stages to a degree detrimental to fish and other river life. A solution of 5 per cent. technical DDT by weight in domestic fuel oil was applied at 1·1 lb. DDT per 1,000 ft. frontage from a TIFA aerosol generator [**35** 128] moving at 1–2 miles per hour. In three field experiments, complete kill of caged adults of *Macronema* spp. and *Hydropsyche* spp. was effected within 15 minutes of exposure. In experiments against dense infestations of these species on isolated groups of fruit trees, the aerosol caused an immediate increase in activity followed rapidly by death. The infestation was almost eliminated and the grass below covered with dead insects. Applications of the aerosol to the mass of insects during the evening flight, had no noticeable effect on the vast numbers. During the remaining hours of the day, the aerosol was effective in the areas that could be reached, but most sheltering places, such as tall trees and woods, provided complete protection. Certain of these sites were sprayed with the DDT solution by portable pressure sprayers, and the effect persisted for 3–4 days.

BRISCOE (M. S.). **The Relation of Insects and Insect-borne Diseases to the Vegetation and Environment in Liberia.**—*Ecology* **33** no. 2 pp. 187–214, 1 map, 53 refs. Lancaster, Pa., 1952.

The following is substantially the author's summary. The relationships of insects and insect-borne diseases to the vegetation and other environmental conditions in Liberia were studied in the field from 1943 to 1945. Liberia has one of the most humid and rainy climates of Africa, and monthly mean temperatures vary from about 70°F. in January to 82°F. in April and May. The six main vegetation types are the outer strand communities, mangrove forest, *Pandanus-Raphia* communities, coastal savannah, tropical rain forest, and gallery (fringing) forest. The tropical rain forest covers about three-quarters of the country.

A list is given of the 262 insects collected (of which about 70 per cent. are identified specifically and the others cited by genera) ; it shows the vegetation

type or types in which each was found, and a separate table shows the food-habits of a few of the phytophagous species. The numerous Diptera included 26 mosquitos [*cf. R.A.E.*, B **37** 221]. A detailed classification of their breeding places is given. *Anopheles gambiae* Giles was the most abundant mosquito in the coastal savannah. It is the most dangerous malaria vector and was the most domestic Anopheline met with. It bred in many biotopes, particularly rice-fields, and the larvae were found almost everywhere during the rainy season except in fast-running water and pools covered with vegetation. It also transmits *Filaria* (*Wuchereria*) *bancrofti* [**39** 36]. The second most important malaria vector is *A. funestus* Giles. The chief parasite was *Plasmodium falciparum*, which was responsible for 98·8 per cent. of all infections. Of the three species of *Glossina* collected, *G. palpalis* (R.-D.) was the only vector of sleeping sickness [*Trypanosoma gambiense*], which has occurred in epidemic form only in the Western Province [**38** 72] near the borders of French Guinea and Sierra Leone.

Young (M. D.) & Johnson jr. (T. H.). **A Malaria Survey of Liberia.**—*J. nat. Malar. Soc.* **8** no. 4 pp. 247–266, 5 figs., 8 refs. Columbia, S.C., 1949.

A survey of malaria in Liberia was made between May and October 1948. Of 10,128 blood smears examined from representative centres of population, 30·65 per cent. showed malaria parasites. The parasite rate was highest (64·45 per cent.) in children 1–4 years old, and the density of parasites was greatest in babies under one year old. *Plasmodium falciparum*, *P. malariae* and *P. vivax* accounted for 83·8, 14·2 and 2 per cent., respectively, of the diagnosed infections, and *P. ovale* was found in one instance. Of the 2,421 infections with *P. falciparum*, 12·06 per cent. had gametocytes. The proportion of gametocyte carriers and the gametocyte density were highest in the younger age groups.

Adult mosquitos were sought in native houses, crevices of large trees in villages, outhouses and under bridges and culverts. Of the 1,153 Anophelines taken, 94·28 per cent. were identified as *Anopheles gambiae* Giles (though a few examples of *A. melas* Theo. were probably included), 5·2 per cent. were *A. funestus* Giles and 0·26 per cent. each were *A. hancocki* Edw. and *A. nili* Theo. *A. gambiae* was found almost exclusively in dwellings. Of 543 females of this species dissected, 6·45 per cent. were infected. Only glands were dissected in most cases. The types of breeding places in which larvae of *A. gambiae* were found in various localities are shown in a table. The larvae often occurred in native wells, even if heavy faecal pollution was evident, and many were seen in previously dry roadside ditches within a few minutes of water being added to the dried mud. Larvae identified as *A. melas* on the basis of survival in sea water were found near the coast or reared from eggs laid by adults taken there. Malaria was hyperendemic throughout the country, but the coastal region was less heavily infected than the interior, the difference being highly significant.

Larvae of *A. smithii* Theo. were found in a small reservoir fed by a cool and heavily shaded mountain stream. They were numerous along the sides of the reservoir but were also present where the stream entered it and the water was turbulent.

Sundararaman (S.) & Peffly (R. L.). **Effectiveness against Flies and Mosquitoes of DDT Applications to Clay, Palm, and Straw Surfaces.**—*J. nat. Malar. Soc.* **8** no. 4 pp. 267–269, 3 refs. Columbia, S.C., 1949.

Laboratory experiments in which the test insects were *Musca domestica* L. and *Anopheles quadrimaculatus* Say were carried out to determine the relative

effectiveness against flies and mosquitos of different DDT formulations when applied as 1 per cent. sprays to leave a deposit of 200 mg. DDT per sq. ft. on three types of surfaces commonly used in the construction of houses in rural India—straw and palm-leaf thatches and clay with a surface wash of cow-dung. A kerosene solution, an emulsified xylene solution and a colloidal suspension prepared from a concentrate containing 10 per cent. DDT, 80 per cent. cellosolve (ethylene glycol monoethyl ether) and 10 per cent. Nopco 1216 (sulphonated sperm oil) [*cf. R.A.E.*, B **36** 11] were tested on all surfaces and four additional formulations on clay only. Batches of the insects were exposed on the treated surfaces under half petri dishes for two hours at intervals after treatment, and the deposit was considered effective if 90–100 per cent. were dead 24 hours later. The solution, emulsion and colloidal suspension were effective against the flies for 28, 28 and 32 weeks, respectively, on straw, 1, 4 and 24 weeks on palm and 0–0, 0–0 and 1–0 weeks (in two series of tests) on clay ; they were effective against the mosquitos for 24, 24 and 32 weeks on straw, 1, 4 and 24 weeks on palm and 0–0, 1–1 and 4–0 weeks on clay. The best of the other treatments on clay, one of two wettable powder suspensions, was effective against both flies and mosquitos for 4 weeks but not for longer.

Mathis (W.) & Quarterman (K. D.). **Preliminary Field Studies on the Use of heavy Dosages of DDT and Benzene Hexachloride as residual Mosquito Larvicides.**—*J. nat. Malar. Soc.* **8** no. 4 pp. 270–279, 8 refs. Columbia, S.C., 1949.

The following is based on the authors' summary of the results of tests made in small land-locked ponds in Georgia. DDT in an emulsified solution gave control of all mosquito larvae, including those of the genus *Anopheles*, for 8–16 weeks when applied at 3 lb. per acre and for 3–5 weeks at 1 lb. per acre. BHC (10 per cent. γ isomer) applied in an emulsified solution at 1 lb. per acre gave control for 5 weeks. A BHC wettable powder containing 25 per cent. γ isomer gave control for 8–11 weeks when applied in the form of a spray at 4 lb. powder per acre.

Other aquatic insects were greatly reduced by all the treatments. Fish were practically eliminated by the heavier DDT treatment and greatly reduced in numbers by the lighter application. They apparently suffered no mortality from two applications of the technical BHC, and some survived treatment with the wettable powder. The DDT treatments should not be used where fish or wildlife are of any significance. Pending further investigation, BHC should be used only with extreme caution.

Results of field tests and observations in biological and chemical laboratory experiments indicate that the long period of effective control obtained with 3 lb. DDT resulted largely from deposits adhering to the vegetation and débris in the ponds. The effectiveness of the treatments was lost if the ponds increased in size during the test period.

Krusé (C. W.), Hess (A. D.) & Ludvik (G. F.). **The Performance of Liquid Spray Nozzles for Aircraft Insecticide Application.**—*J. nat. Malar. Soc.* **8** no. 4 pp. 312–334, 8 figs., 7 refs. Columbia, S.C., 1949.

There has been a considerable difference in opinion as to the most practical droplet size for DDT solutions dispersed from aircraft to control larvae of *Anopheles quadrimaculatus* Say. Thermal aerosols produced by exhaust generators and designed to have droplets with a mass median diameter (MMD) of 35–50 microns have given excellent control on impounded waters of the Tennessee Valley Authority for several years [*cf. R.A.E.*, B **37** 97], but the need to treat smaller and less accessible breeding places involves an increase in height

of flight, which noticeably decreases the number of aerosol particles deposited on the area, and the need to make applications during adverse weather conditions results in sparse and irregular distribution of aerosol particles. Investigations were therefore carried out on the use of simple nozzles to atomise the solutions. These can be attached at the wing tips to give wider swathes, may be more economical than exhaust generators to fix and maintain, and do not affect the operation of the aeroplane engine. This report is concerned mainly with basic studies on the effect of the nozzle in breaking up liquids and the importance of this in the application of DDT by aeroplane against mosquito larvae.

S. Nukiyama and Y. Tanasawa developed formulae of value in studies of the particle sizes produced by atomising nozzles ; these accounted for atomisation in a simple nozzle in two stages, the first at the orifice, which the liquid leaves as a high-velocity sheet, and the second at the interaction of this sheet with the air, which reduces it to droplets. In these calculations, D_0, the diameter in microns of a single droplet with the same ratio of surface to volume as a representative sample of droplets in the spray spectrum, was used as a definition of droplet size in place of the MMD of the droplets. A graphical method is given for determining D_0 for a given droplet count from the frequency distribution and class interval of droplet sizes ; it involves the determination of a constant, q, which is larger when the droplets are relatively homogeneous and the range of size relatively narrow than when the droplet range is wide. D_0 is shown to be less affected than the MMD by the presence of a few large droplets in the sample counted, and it appears to vary directly with the viscosity and surface tension of the liquid sprayed and inversely with its velocity (a function of pressure) and specific gravity, viscosity being particularly important. An empirical equation expressing these relationships is given. The influence of speeds of flight of 0–180 miles per hour on the composition of spray spectra produced under pressures of 20–100 lb. per sq. in. from nozzles directed forwards or backwards along the line of flight supported the theory that after the liquid leaves the nozzle, the degree to which it is broken up by the air is proportional to the difference in velocity between the two. When the nozzles were directed forwards, D_0 decreased as the speed of the aeroplane increased, but when they were directed backwards, it increased as the velocity of the air passing the aeroplane approached the liquid discharge velocity and decreased again after the air velocity exceeded the liquid velocity.

It is shown that the number, size and distribution of particles produced by an atomising device bear a close relation to the control of *Anopheles* larvae. Particles 0–50 microns in diameter give the most even distribution and the widest swathe (about 260 ft. with a flying height of 25 ft.), but are subject to the effects of adverse weather conditions that make their deposition uncertain. Particles of an intermediate range of 50–100 microns are less evenly distributed, but this size appears to give an optimum number of droplets per sq. in. and a swathe width of about 200 ft. ; it is calculated that a particle with a diameter of 70–80 microns contains a dose of DDT lethal to a fourth-instar larva of *A. quadrimaculatus* when 20 per cent. (w/w) DDT in Velsicol NR–70 is used. Large particles (100 microns and over) show the best mass deposition and are least affected by adverse weather, but have a limited swathe distribution (about 120 ft.) and are relatively so few that it is questionable whether adequate distribution for control (at least one particle containing a lethal dose per sq. in.) could be obtained. At least 0·008 oz. DDT per acre in open situations and about 0·08 oz. per acre where there is heavy cover are required to give satisfactory control. The equipment used is a factor in determining the spray range to be employed. The helicopter has a large downwash that should favour the dispersion and deposition of small particles, whereas fixed-wing aircraft have much less downwash, and a particle range of 50–100 microns should be selected.

If large particles are desired, the number produced should be increased by increasing the volume discharged, and the concentration of DDT in the solution should be reduced. The location of the spray outlet with respect to the downwash determines the amount of material deposited. Various positions have been suggested, but in this study the nozzles were on the wing tip at about the three-quarter cord.

After a spray application made over open country under almost ideal meteorological conditions, plotting the weight of DDT deposited per acre and the number of particles per square inch against the distance from the line of flight resulted in a bimodal curve and one more closely approximating a normal distribution curve, respectively.

SNOW (W. E.). **Studies on portable Resting Stations for** *Anopheles quadrimaculatus* **in the Tennessee Valley.**—*J. nat. Malar. Soc.* **8** no. 4 pp. 336–343 3 figs., 3 refs. Columbia, S.C., 1949.

The value of modified privy-type traps [*cf. R.A.E.*, B **35** 56] and weathered nail kegs [**31** 52] for measuring populations of *Anopheles quadrimaculatus* Say was tested in 1949 in the vicinity of an old hollow tree that is one of the most favoured natural resting places of this Anopheline in the Tennessee Valley, by making mid-day collections of the mosquitos resting in the three types of shelter. The walls of the privy-type shelters were divided horizontally into quarters, each of which was covered by a removable panel so that the entry of mosquitos at various levels could be studied. Ingress baffles or trapping sections made of screen wire with a narrow horizontal slit allowing the mosquitos to enter the trap were interchangeable with the removable wall panels. The studies indicated that this type of trap was more attractive than the keg or hollow tree, and was most effective when it was equipped with a west baffle and had the lowest west panel removed. With this combination of a pair of entrances, it yielded over 20 times as many adults of *A. quadrimaculatus* on an average as a keg and seven times as many as the hollow tree. The various shelters were near a breeding area, and about 65 per cent. of the thousands of adults taken in them were males.

EYLES (D. E.) & JEFFERY (G. M.). **The experimental Transmission of** *Plasmodium falciparum* **by** *Anopheles albimanus.*—*J. nat. Malar. Soc.* **8** no. 4 pp. 344–345, 2 refs. Columbia, S.C., 1949.

A Panama strain of *Anopheles albimanus* Wied. transmitted a strain of *Plasmodium falciparum* from Panama at all of nine attempts and a strain from South Carolina on one occasion out of two. No significance is attributed to the failure, as the mosquitos were not heavily infected.

PINOTTI (M.). **The biological Basis for the Campaign against the Malaria Vectors of Brazil.**—*Trans. R. Soc. trop. Med. Hyg.* **44** no. 6 pp. 663–682, 6 graphs, 5 maps, 10 refs. London, 1951.

Malaria has recently been brought under control in a large part of Brazil, where it is extremely widespread in endemic form, through the use of measures based on the bionomics of the Anopheline vectors. In the area north of 25° S. lat., which includes most of the country, the vectors belong to the subgenus *Nyssorhynchus* of *Anopheles*, and in the area south of it they belong to the subgenus *Kerteszia* [*R.A.E.*, B **35** 127 ; **38** 46]. The vast northern area is divided into the interior, where the vector is *A. darlingi* Root, and the coast, where the main vector is *A. aquasalis* Curry, but *A. darlingi*, *A. albitarsis* var. *domesticus* Galvão & Damasceno or both may also play a part [*cf.* **36** 5, 90 ;

38 44]. Members of the subgenus *Kerteszia* breed in bromeliads and they make a malaria problem only in southern Brazil and Trinidad [**37** 42 ; **41** 15]. The two species involved in transmission in Brazil are *A. cruzii* D. & K. and *A. bellator* D. & K., which are essentially similar in their habits, though *A. cruzii* predominates in heavily forested regions, while *A. bellator* prefers the more open and sunny coastal zone. The area over which they act as vectors in Brazil is some 15,500 sq. miles in extent, includes several important cities and affects a population of nearly a million people. Over this area, species of *Kerteszia* formed 90–100 per cent. of the Anophelines caught inside houses [*cf.* **35** 127]. The biological characteristics of all the vector species are reviewed.

An account is given of a campaign designed first to reduce the importance of malaria by household spraying with DDT in all affected areas, supplemented by drug treatment, and secondly to eradicate malaria from the country. It is evident that the campaign of house spraying is logically founded as *A. darlingi* and *A. albitarsis domesticus* are essentially domestic and *A. aquasalis*, *A. cruzii* and *A. bellator* are also frequently attracted to houses, though not invariably so. The number of houses sprayed increased progressively from 6,419 in 1946 to 2,364,267 in 1949, when a population of about 12 millions was protected and there was a distinct fall in malaria prevalence.

When the first stage of the campaign was largely completed, attempts at eradication were begun. These are still in their initial phase in the case of the species of the subgenus *Nyssorhynchus*, as house spraying has had little or no effect on their natural breeding. The attack on *Kerteszia*, which consisted of the destruction of bromeliads, began in 1943 when it had first been proved that they were responsible for endemic malaria in southern Brazil [*cf.* **33** 41 ; **35** 127]. The first measures were taken in Florianópolis, where the city area of some 12 square miles was cleared of bromeliads by the manual removal and destruction of over 20 millions and then became free from malaria. Some other centres of population were surrounded by forests in which the bromeliads could not be destroyed individually, and it became necessary to cut down the forest and carry out a programme of reafforestation with trees that are not readily parasitised by bromeliads. Spraying with copper sulphate, which is extensively used in Trinidad [**37** 43], is not applicable in most of Brazil, because of the difficult nature of the terrain, but more effective herbicides are being sought for use near urban areas. House-spraying with DDT reduced transmission to a minimum. Attempts to control *A. bellator* and *A. cruzii* by spraying the forest with DDT and BHC from a helicopter resulted in excellent immediate control of the sylvan mosquitos, but populations had been restored to their original level after 20 days.

Tables are given showing the blood parasite indices in 17 localities before and after house-spraying and the number of cases of malaria in 33 localities in which house-spraying or bromeliad control was carried out. The total number of cases in the 33 localities fell from 33,945 in 1945 to 4,703 in 1949.

McArthur (J.). **The Importance of** *Anopheles leucosphyrus*.—*Trans. R. Soc. trop. Med. Hyg.* **44** no. 6 pp. 683–694, 1 map, refs. London, 1951.

The following is substantially the author's summary. The progress of knowledge regarding the importance of *Anopheles leucosphyrus* Dön. as a vector of malaria is discussed. *A. leucosphyrus* is distributed across Asia from India to Celebes and from Java to Formosa and has several varieties [*R.A.E.*, B **40** 141]. It was recorded as suspected of transmitting malaria on indirect evidence in 1914 in North Borneo [**3** 11] and subsequently on epidemiological evidence in Sarawak, Indo-China, Burma, Assam and elsewhere. It was first recorded as having a great preference for human blood in 1932 in the Netherlands Indies [**20** 168], and the same observation was later made in Borneo, Assam and

Bengal, Indo-China and Burma. It was first recorded as having been found infected with malaria parasites on dissection (in 1918) in Sumatra [**10** 5] and positive for sporozoites (in 1938) in Assam [**30** 104]. The results of sixty series of dissections made in various parts of Asia from India to Celebes are given in a table. More than half of them are positive. Infections in *A. leucosphyrus* have been recorded in Burma [**36** 204 ; **38** 201], Dutch Borneo [**23** 20, 21], North Borneo [**36** 204] Brunei, Sarawak, Malaya and Indo-China [**26** 204] as well as in Assam and Sumatra, and var. *hackeri* Edw. has been found infected in Celebes. Except in Celebes, all the evidence indicates that only the type form is of importance as a vector of malaria. It is the most widespread. From a consideration of the wide distribution of *A. leucosphyrus*, its elusive nature, its preference for human blood, the epidemiological evidence, the paucity of dissections and the fact that it has been found infected wherever it has been dissected in adequate numbers, it is considered to be more important as a vector of malaria throughout its range in Asia than has hitherto been appreciated.

Nair (C. P.). **Studies on DDT Barrier Spray with Reference to local Rainfall and seasonal Incidence of Mosquitoes.**—*Trans. R. Soc. trop. Med. Hyg.* **44** no. 6 pp. 741–746, 6 refs. London, 1951.

In 79 experiments made in 11 centres in the Klang District, Malaya, in 1945 and 1946, a belt 50 yards wide around chosen buildings was sprayed with a solution of DDT in kerosene as a protection against Anophelines. Whether the local malaria vector was *Anopheles letifer* Sandosham, *A. sundaicus* (Rdnw.) or *A. maculatus* Theo., one application of spray retained its effectiveness for about the same time, not more than 15 days. The daily rainfall and periodical night mosquito catches in the locality were recorded and analysed to determine whether duration of effectiveness was related to rainfall or seasonal fluctuations in mosquito populations. Representative results are given from trials in which 5 or 6 gals. 5 per cent. DDT solution per acre was used, and rainfall on the days of spraying and total rainfall during the observation periods (9–12 days) are both shown. The results fail to indicate that either initial or total rainfall decreased the duration of effectiveness of the deposit, irrespective of whether 5 or 6 gals. spray was applied. A study of mosquito catches in the different control areas and in catching stations independent of the experiments showed that seasonal incidence was high in November and December and again in May and June. The effect of the barrier spray lasted for only about ten days during these two periods and for 12 days at other times.

Chow (C. Y.) & Balfour (M. C.). **The natural Infection and seasonal Prevalence of *Anopheles* Mosquitoes in Chefang and Vicinity, Yunnan-Burma Border.**—*Chin. med. J.* **67** no. 8 pp. 405–413, 4 refs. Shanghai, 1949.

Much of the work described in this paper has been noticed from an earlier one [*R.A.E.*, B **31** 215]. Further dissections confirmed that *Anopheles minimus* Theo. was the only species of *Anopheles* that contained malaria parasites and showed that it could be infected in all months of the year. They brought the infection rate up to 1·1 per cent. *A. minimus* was the predominant species and was found in large numbers throughout the year. It was most abundant in October and November.

Hurlbut (H. S.) & Thomas (J. I.). **Observations on the experimental Transmission of Japanese Encephalitis by Mosquitoes.**—*Amer. J. trop. Med.* **30** no. 5 pp. 683–688, 5 refs. Baltimore, Md., 1950.

An account is given of two series of experiments with Japanese B encephalitis and *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.), which showed that

mice infected by mosquitos that had fed on infected mouse brain developed a sufficiently high concentration of virus in the blood to produce a transmissible infection in mosquitos that fed on them. In the second series, the blood was titrated by intracerebral inoculation of mice with serial ten-fold serum dilutions, the titre being the estimated median lethal dilution. It was found that mice 3–5 days old when infected developed blood titres ranging from $10^{-3\cdot6}$ to $10^{-5\cdot2}$ while those 7–12 days old had titres of from $10^{-2\cdot8}$ to $10^{-3\cdot8}$. The mosquitos that engorged on these mice transmitted the virus when infected by blood having titres with exponents of −2·8, −3·2, −4·5 or −5·2. Within the group of mosquitos receiving virus by feeding on mice, the number of successful transmissions was not directly proportional to the amount of virus in the infective blood.

LAEMMERT jr. (H. W.) & KUMM (H. W.). **The Susceptibility of Howler Monkeys to Yellow Fever Virus.**—*Amer. J. trop. Med.* **30** no. 5 pp. 723–731, 3 figs., 11 refs. Baltimore, Md., 1950.

KUMM (H. W.) & LAEMMERT jr. (H. W.). **The geographical Distribution of Immunity to Yellow Fever among the Primates of Brazil.**—*T.c.* pp. 733–748, 2 maps, 32 refs. **A Study of the Concentration of Yellow Fever Virus which will infect certain Species of *Aedes* Mosquitoes.**—*T.c.* pp. 749–755, 1 graph, 5 refs.

Experiments are described in the first paper in which two species of Brazilian howler monkeys (*Alouatta*) were shown to be highly susceptible to the Olímpio Christo strain of jungle yellow-fever virus transmitted by mosquito bite. *Aëdes scapularis* (Rond.) transmitted the virus cyclically by biting from an individual of *Alouatta caraya* that had acquired it by the bite of *Aëdes aegypti* (L.) to three other monkeys of the same species, and *A. leucocelaenus* Dyar & Shann. transmitted it cyclically to three individuals of *Alouatta guariba clamitans*. All these infections were fatal. The blood of the infected monkeys was titrated by a method similar to that noticed above [see preceding abstract], except that the titre was the serum dilution required to cause infection (with or without death) in 50 per cent. of the mice. The highest titre was $10^{-8\cdot8}$. Two batches of *Aëdes scapularis* fed on a monkey with a titre of $10^{-2\cdot3}$ did not become infected, but yellow fever was transmitted by a batch of 16 that had fed when the titre was 10^{-3}. The titres in the successful transmission experiments with *A. leucocelaenus* were higher than this. The facility with which laboratory transmissions were obtained with *Aëdes scapularis* suggests that this species may ensure the survival of the virus in the cold and dry season in southern Brazil, when mosquitos of the genus *Haemagogus* are rarely seen [*R.A.E.*, B **40** 134]. It is a hardy, long-lived species with a long flight-range and has been found in certain areas throughout the winter.

The wide extent of specific immunity demonstrated in the survey described in the second paper among primates caught in nature confirms the fact that jungle yellow fever had prevailed throughout most of Brazil during the past 15 years.

In the work described in the third paper, the concentration of circulating virus (Olímpio Christo) necessary to infect three species of *Aëdes* was studied. The vertebrate hosts were howler monkeys (*Alouatta caraya*) and marmosets (*Callithrix jacchus*). The lowest titre at which the virus was acquired by biting was 10^{-3}, when both *A. aegypti* and *A. scapularis* became infected. Infection was also transmitted by one female out of four of *A. scapularis* that had been infected at this titre. In all tests in which mosquitos were fed on hosts circulating virus at titres of 10^{-5} or above, half or more became infected after extrinsic incubation periods of at least 28 days at 28°C. [82·4°F.], and at titres above $10^{-5\cdot5}$ in the source animals, 90–100 per cent. of the mosquitos usually

became infected. The percentages of *A. scapularis* that acquired infection were significantly higher than those of *A. aegypti* at both high and low virus concentrations. Very small numbers of *A. leucocelaenus* were used, but the curves representing the percentages of mosquitos that became infected after feeding on hosts circulating the virus at various titres were very similar for the three species.

MISSIROLI (A.). **The Control of Domestic Insects in Italy.**—*Amer. J. trop. Med.* **30** no. 5 pp. 773–783, 4 figs. Baltimore, Md., 1950.

The early stages of the campaign begun in 1946 for the eradication of malaria from Italy by using DDT to destroy Anophelines in houses are described [*cf. R.A.E.*, B **38** 130]. The treated houses were freed from mosquitos and other Diptera in the first season, there were no deaths from malaria in Italy in 1948 for the first time in history and the number of cases fell rapidly. A strain of *Musca domestica* L. resistant to DDT appeared in great numbers in 1947 [**38** 129], but it was eliminated from the towns in 1948 by means of chlordane (Octa-Klor), and the extensive use of this insecticide in rural areas in 1949 was also effective. Preliminary investigations showed that application of chlordane at 2 gm. per sq. metre to stables, kitchens and entrance halls only was sufficient to eliminate DDT-resistant flies. In 1948 and 1949, a mixture containing equal parts of DDT and chlordane was used, as it was expected that chlordane would remain active for only about four months. However some action was found to persist until the next season, and slower action in winter is compensated for by longer contact, so that complete destruction of the hibernating flies is obtained. Nevertheless, the number of flies in the following season seemed to be greater in areas treated with chlordane only than in areas treated with DDT and chlordane, and this is attributed to synergism. A five-year plan for the control of *M. domestica* was prepared ; it was proposed to use a spray containing chlordane and DDT in the ratio of 3 : 1 in emulsified solution at a rate giving a deposit of 1·5 gm. chlordane and 0·5 gm. DDT per sq. metre.

STABLER (R. M.). **Parasitism of Mosquito Larvae by Mermithids (Nematoda).**—*J. Parasit.* **38** no. 2 pp. 130–132, 2 figs., 10 refs. Lancaster, Pa., 1952.

In August and September 1944, 76 of 146 fourth-instar larvae of *Aëdes vexans* (Mg.), four of 53 of *Culex salinarius* Coq. and ten of 18 of *C. pipiens* L. collected in tide and permanent pools at the edge of a creek in south-eastern Pennsylvania were found to be parasitised with Mermithid larvae. The worm emerged through a hole in the side of the thorax of the host larva, which invariably died very soon afterwards. Sectioned thoraces showed that the worms lay coiled and twisted in the haemocoele, just under the exoskeleton. No gross anatomical change attributable to their presence was evident.

DE ZULUETA (J.). **Comparative Oviposition Experiments with caged Mosquitoes.**—*Amer. J. Hyg.* **52** no. 2 pp. 133–142, 15 refs. Baltimore, Md., 1950.

The following is substantially the author's summary. The effect of various factors on the oviposition behaviour of caged females of *Anopheles darlingi* Root and *Culex pipiens fatigans* Wied. was studied in the laboratory in Villavicencio, Colombia. Each experiment was repeated several times until a large number of eggs had been laid, as this, as well as fairly large colonies, has been found necessary for uniform results. Two pans were put on the floor of the cage in each experiment. When the effect of chemicals or of organic matter was being tested, one pan was filled with rain or distilled water as a control. To avoid the effect of the position of the pans, which has been shown to be important in the choice of an oviposition site by *A. darlingi* [*R.A.E.*, B **39**

193], this was alternated in each trial in all experiments, though it was found in the course of them that position had no effect on the behaviour of *C. p. fatigans*.

When given the choice of a blue-bottomed pan and one with a white-tiled bottom, females of *A. darlingi* completely avoided the white pan in bright light, but began to lay eggs in it when the light was reduced to the limit at which the pans could be seen by two observers. When the light was further reduced so that the pans could not be detected by the human eye, about equal numbers of eggs were laid in the two pans. In complete darkness, the gravid females could not find the water and died without ovipositing. Forcing the females into contact with a wet surface by putting them in small vials showed that complete darkness does not inhibit development of the ovaries or oviposition. *A. darlingi* showed no preference between two samples of water from natural breeding places and distilled water, but slightly preferred control water to a 1 per cent. solution of sodium chloride or magnesium sulphate. Samples of water containing a large amount of organic matter and having a definite smell were repellent. These findings, together with the results already published [*loc. cit.*], indicate that the oviposition behaviour of *A. darlingi* is governed mainly by visual stimuli. Tactile and scent stimuli may also be of importance, but apparently chemical stimuli are not.

A parallel series of experiments with *C. p. fatigans* showed that this mosquito did not discriminate between dark and white backgrounds and could find the water in the pans in complete darkness. The females seemed to be practically indifferent to 1 per cent. magnesium sulphate in the water but were completely repelled by 1 per cent. sodium chloride and showed a strong preference for water with a high organic content as compared with control water. In the last case, there was evidence that they were guided mainly by the smell rather than by the chemical content of the samples. These results tend to support the view that visual stimuli are of no importance in governing the oviposition behaviour of *C. p. fatigans* and that this mosquito is guided mainly by chemical and scent stimuli in choosing an oviposition site.

Chamberlain (R. W.). **An Investigation on the Action of Piperonyl Butoxide with Pyrethrum.**—*Amer. J. Hyg.* **52** no. 2 pp. 153–183, 6 graphs, 20 refs. Baltimore, Md., 1950.

The insecticidal effectiveness of pyrethrins is not long-lasting, but in 1948, W. E. Dove reported that a deposit of 100 mg. piperonyl butoxide and 5 mg. pyrethrins per sq. ft. retained its effectiveness against house-flies [*Musca domestica* L.] for 131 days. In this paper, accounts are given of three series of experiments undertaken to determine how piperonyl butoxide increases the toxicity and the duration of effectiveness of a pyrethrum deposit. In the first, house-flies were exposed in one order or another to variously aged deposits of piperonyl butoxide and pyrethrum ; in the second, piperonyl butoxide and pyrethrum were applied to separate areas of house-fly integument to determine whether the mode of action is an alteration of cuticle permeability to allow a more rapid penetration of pyrethrins ; in the third, the work was designed to determine whether the mode of action of piperonyl butoxide as a pyrethrum synergist is to inhibit a detoxifying action of insect lipase.

The following is based on the author's summaries of the results. Contact with a panel treated with a combination of piperonyl butoxide and pyrethrum resulted in a much greater and more rapid knockdown of house-flies than contact with one treated with either alone. No ill effects could be noted as the result of contact with deposits of piperonyl butoxide only. Exposure of flies first to a surface treated with piperonyl butoxide and then to one treated with pyrethrum, either immediately or after an interval of one or three hours, resulted in the same type of synergistic action as occurred in flies exposed to a

mixture of the two materials. Exposures in the reverse order were less effective. If the flies were transferred immediately from contact with pyrethrum to piperonyl butoxide, a temporary knockdown occurred, but if an intervening rest period was allowed, the subsequent contact with piperonyl butoxide had no apparent effect. Only brief contact with piperonyl butoxide was needed to bring about the maximum synergistic effect when flies were transferred to pyrethrum. The effectiveness of initial exposure to piperonyl butoxide in bringing about knockdown of flies upon their subsequent contact with an aged pyrethrum-treated panel did not appear to be the result of conveyance of enough piperonyl butoxide on the tarsi to dissolve the pyrethrum, as initial exposure to oils that are solvents for pyrethrum had no effect. A way in which piperonyl butoxide and pyrethrum act together was disclosed by the finding that the presence of piperonyl butoxide decreased the rate at which pyrethrum deposits lost their toxicity. This property, although not explaining the synergism that occurs in mixed space sprays, accounts for much of the effectiveness of a mixture of the two materials used to leave a toxic deposit.

A technique is described for applying very small measured doses of pyrethrum and piperonyl butoxide to separate cuticular areas of house-flies and for preventing contamination between them. It was used in four tests, involving a total of 230 flies, in which the concentrations of piperonyl butoxide and pyrethrum were such that each used alone caused no knockdown. The application of piperonyl butoxide to the heads and pyrethrum to the abdomens resulted in knockdown similar to that caused by the application of similar amounts of both compounds to the abdomens. The findings suggest that the synergist acts by inhibiting a detoxifying mechanism.

Within the temperature range of 15–25°C. [59–77°F.], house-flies placed in contact with a pyrethrin deposit were knocked down more rapidly at lower temperatures. This supports the view that enzymic detoxification of pyrethrins occurs, as enzymes are less active at reduced temperatures. Temperature appeared to have little effect on the rate of knockdown of flies exposed to a deposit of mixed piperonyl butoxide and pyrethrins. Incubation of an extract of cockroaches (*Periplaneta americana* (L.)) with a weak emulsion of purified pyrethrins, which was then tested against fourth-instar larvae of *Aëdes aegypti* (L.), brought about some inactivation of the toxic principles, though not so much as was reported for mixtures of pyrethrum and armyworm tissue [*R.A.E.*, A **27** 524]. It was shown by a manometric technique that cockroach and house-fly extracts were rich in lipase, which hydrolysed Tween 20 and mannitan monolaurate rapidly and pyrethrins less rapidly. Addition of piperonyl-butoxide emulsion to the reaction mixture reduced hydrolysis by 25–40 per cent. Exposure of living cockroaches to piperonyl butoxide did not reduce the activity of lipase subsequently extracted from them. This shows that either the enzyme was not greatly affected or the effect was easily reversible, reactivation occurring upon removal of the synergist with acetone and ether in preparing the extract. There was no apparent correlation between the efficacy of a number of compounds as lipase inhibitors and their known activity as pyrethrum synergists.

The significance of these findings in regard to the hypothesis that piperonyl butoxide acts to inhibit lipase is discussed, and it is concluded that the results lend some support to the hypothesis.

Wanson (M.) & Lebied (B.). **L'habitat larvaire de *Simulium renauxi* Wanson et Lebied. Description de la pupe et des terminalia du mâle.**—*Rev. Zool. Bot. afr.* **44** fasc. 1 pp. 25–29, 3 refs. Tervuren, 1950.

Immature stages of *Simulium renauxi* Wanson & Lebied [*R.A.E.*, B **41** 29] were taken in 1950 on crabs (*Potamonautes lueboensis* Rathbun) in a clear, fast-running, rocky forest stream that flows into the Inzia in the western Belgian

Congo. The average number of larvae and pupae seen per crab was 3–10 on a small individual and 10–25 on a full-grown one. Descriptions are given of the pupa and cocoon and the terminalia of males dissected from pupae. The pupa has eight respiratory filaments. Since the female of *S. renauxi* was described [*loc. cit.*], the authors have had the opportunity of examining females of *S. neavei* Roub. sent from Kenya by McMahon and have found no morphological differences, although the colour of the scales was different. Moreover, the cerci of the Kenya specimens were not rectangular in outline when viewed laterally, as they were shown to be by Gibbins in *S. neavei* from Uganda [**25** 229], but conformed with the Congo material. P. Freeman identified the Congo material as *S. neavei*. If this identification is correct, *S. renauxi* is a synonym of *S. neavei*, and the Simuliid obtained from pupae with ten respiratory filaments and described as *S. neavei* by Grenier [**41** 49] is another species. It is, however, possible that *S. renauxi* is a species that is closely allied to *S. neavei* but differs from it in having silver scales and a pupa with eight respiratory filaments. Pending further study of the problem, the authors adopt the second view [but evidence that the first one may be correct is afforded in a subsequent paper by McMahon (**40** 5), who did not refer to this paper but stated that the adults of both sexes of the Simuliid that he identifies as *S. neavei* have golden scales while the pupa has eight respiratory filaments, and that the species regarded as *S. neavei* by Grenier, which was obtained from pupae with ten respiratory filaments attached to mayfly nymphs, also differs in the claws of the female have a slight tooth].

Floch (H.) & Abonnenc (E.). **Sur la synonymie de quelques phlébotomes sud-américains.**—*Publ. Inst. Pasteur Guyane* no. 212, 13 pp., 13 refs. Cayenne, 1950.

The authors point out that the "type material" of *Phlebotomus cruciatus* Coq. originally consisted of five females that were possibly not conspecific and that the specimen from this material examined by Fairchild & Hertig [*R.A.E.*, B **39** 53] was a paratype. They conclude that the type is non-existent and that *cruciatus* remains a *nomen nudum*. If Fairchild & Hertig's "*cruciatus*" from Mexico and Guatemala is not *P. gomezi* Nitzu., it should be described as a new species. As regards the other species discussed by Fairchild & Hertig [*loc. cit.*], the authors consider that *P. suis* Rozeboom is a synonym of *P. gomezi*, but that *P. japignyi* Floch & Abonnenc is distinct, as the females differ in the length of the spermathecal ducts and the male of *P. gomezi* is not known. They do not agree that *P. yucatanensis* Galliard is a synonym of *P. trinidadensis* Newst. as they have examined the single male in Galliard's type material and find that it lacks the fine hairs on the inner aspect of the coxite that are present in *trinidadensis*. They also consider that *P. baduelensis* Floch & Abonnenc (of which they regard *P. villelai* Mangabeira as a synonym) is a valid and well defined species, disagreeing completely with Dampf [**37** 215], who synonymised it with *yucatanensis* by virtue of designating one of the two females of Galliard's type material of the latter as the type instead of the male. *P. baduelensis* has 13–16 hairs at the base of the coxite. The females identified as *P. trinidadensis* by Fairchild & Hertig, and those of *P. yucatanensis* and *P. baduelensis* can be distinguished only if their geographical distribution or associated males are known.

Pereira Barretto [**37** 200] referred the female associated by the authors with *P. rorotaensis* Floch & Abonnenc to *P. oswaldoi* Mangabeira, which is not known to occur in French Guiana. They show by a comparison of the numbers of each sex of *rorotaensis* and *baduelensis* taken by them in various localities and various months without bait or light that the female was correctly associated

with *rorotaensis*. They state that Dampf's synonymising of *rorotaensis* with *villelai* [**37** 215–216] is indefensible, as Pereira Barretto reared the latter species, of which the female is distinct from that of *rorotaensis*.

HOLDENRIED (R.). **Sylvatic Plague Studies. VII. Plague Transmission Potentials of the Fleas *Diamanus montanus* and *Polygenis gwyni* compared with *Xenopsylla cheopis*.**—*J. infect. Dis.* **90** pp. 131–140, 9 refs. Chicago, Ill., 1952.

Sylvatic plague is widely distributed in the western United States, the California ground squirrel (*Citellus beecheyi*) is one of the rodents most commonly infected, and *Diamanus montanus* (Baker), which is one of its fleas, has been considered to be an important vector [*cf. R.A.E.*, B **32** 108]. Reports of its vector efficiency have, however, been conflicting, and it has been suggested that the species may include local strains that differ in their ability to transmit the disease. The experiments described in detail in this paper were carried out to compare the transmission potentialities of six strains of *D. montanus* from different parts of central California and of *Polygenis* (*Rhopalopsyllus*) *gwyni* (Fox) from Georgia with that of *Xenopsylla cheopis* (Roths.). *P. gwyni* was included because it is a flea that regularly infests both cotton rats (*Sigmodon hispidus*) and Norway rats (*Rattus norvegicus*) in the south and south-western United States and so might spread plague from cotton rats to domestic rats. The fleas were fed on mice with intense plague bacteraemia, and after a fast of 1–3 days they were fed individually on uninfected mice, either by continuous exposure or exposure for limited times in vials.

Of the 446 examples of *D. montanus* used, only nine (2 per cent.) transmitted plague, and these nine belonged to two strains from areas believed to be free from the disease, whereas three of the other four strains were from areas with a history of sylvatic plague. The vectors represented 4 and 5 per cent. of their respective strains, and it is concluded that the numbers and percentages concerned were too small to permit the significance of the differences between strains to be determined. A greater proportion of *D. montanus* than of *X. cheopis* became clear of plague bacilli after infective meals, and clearing was also more rapid [*cf. loc. cit.*]. The mechanism of clearing is not understood.

Of 88 adults of *P. gwyni* infected, 24 (27 per cent.) transmitted plague, and ten infected two or three mice each. This species has not been studied in an epizootic and its effectiveness as a vector under such conditions is not known, but it would presumably be great. *X. cheopis* was the most effective vector of the three species, as 60 per cent. of infected individuals transmitted the disease once or more. The greatest opportunity for sylvatic plague to spread to urban areas appears to occur in certain parts of the southern and south-western states where both *P. gwyni* and *X. cheopis* occur on field-dwelling domestic rats. Though plague is not known to exist in these areas, the danger should not be ignored.

PAPERS NOTICED BY TITLE ONLY.

ARMSTRONG (G.), BRADBURY (F. R.) & BRITTON (H. G.). **The Penetration of the Insect Cuticle by DDT and related Compounds.**—*Ann. appl. Biol.* **39** no. 4 pp. 548–556, 2 graphs, 12 refs. London, 1952. [See *R.A.E.*, A **41** 120.]

FEINSTEIN (L.). **A new Reaction and Color Test for Allethrin and Pyrethrins.**—*Science* **115** no. 2983 pp. 245–246, 1 ref. New York, N.Y., 1952.

Joint Blowfly Control Committee. **Control of Body-strike in Sheep. Interim Recommendations.**—4 pp. [Melbourne, Commonw. sci. industr. Res, Org.] 1950 ; also *Agric. Gaz. N.S.W.* **61** pt. 11 pp. 557–559. Sydney. 1950 ; also *J. Dep. Agric. S. Aust.* **54** no. 7 pp. 332–335, 2 figs. Adelaide, 1951.

These recommendations for using DDT and BHC against blowflies causing body strike (as distinct from crutch strike) of sheep in Australia are based on experience gained in laboratory experiments and field trials under practical conditions. The sheep are sprayed with 1 per cent. DDT or 0·05 per cent. γ BHC so that the sides of the neck, the shoulders, the withers and the sides of the body about half-way down are covered. Particular attention should be paid to the shoulder and withers and, in the case of rams, the head and base of the horns, on which 0·25 gal. 2 per cent. DDT or 0·075 per cent. γ BHC should be used. The quantity of fluid applied per sheep should range from 0·25 gal. for small sheep in short wool to 0·5 gal. for larger sheep in longer wool. Under experimental conditions, when sprayed sheep were wetted frequently with the equivalent of 1 in. of rain and were exposed periodically to a dense population of blowflies in an insectary, 1 per cent. DDT gave complete protection for 54 days and 0·05 per cent. γ BHC for 33 days. Field evidence has confirmed the effectiveness of BHC at this very low concentration.

The two insecticides differ a little in their action, because BHC is the more volatile. Both prevent the flies from ovipositing in the fleece when they are present in adequate amounts, but DDT affords a longer period of protection. Both kill larvae that feed in the treated parts of the fleece, but BHC, unlike DDT, also kills those in neighbouring untreated fleece and so provides a more uniform barrier. Should a wave of body strike develop, BHC should be used freely, applied either as a spray to wet the fleece of uninfested sheep or jetted into infested areas of fleece.

Keegan (H. L.), Blauw (A. S.) & Anderson (R. I.). *Latrodectus geometricus* **Koch on Luzon.**—*Amer. J. trop. Med.* **30** no. 6 pp. 901–907, 4 figs., 11 refs. Baltimore, Md., 1950.

The following is taken from the authors' summary. *Latrodectus geometricus* Koch is recorded for the first time from the Philippine Islands, where it was found in three localities on Luzon. It is a common house-infesting species at one air force base, with habits similar to those of *L. mactans* (F.) in the United States. Observations on length of life, habits and egg-sac production are made on the basis of the study of a colony maintained in the laboratory. Effects of the venom on mice, guineapigs and cats were similar to those reported by other workers using venoms of *L. mactans* and *L. hasseltii* Thorell, but indicate a lower degree of toxicity for these animals. There are no records of *L. geometricus* biting man on Luzon, but the demonstrated toxicity of its venom combined with its close resemblance to *L. mactans* and *L. hasseltii* suggests that some of the bites attributed to those species may have been caused by *L. geometricus*, which occurs in the ranges of both. DDT in spray, aerosol and powder form has been found effective in destroying both adult and immature spiders. Natural enemies on Luzon include unidentified predacious wasps and the egg-sac parasite, *Eurytoma arachnovora* Hesse, which has not previously been reported from the Philippines.

Jenkins (D. W.). **Bionomics of *Culex tarsalis* in Relation to Western Equine Encephalomyelitis.**—*Amer. J. trop. Med.* **30** no. 6 pp. 909–916, 2 maps, 20 refs. Baltimore, Md., 1950.

The following is based on the author's summary. The North-American distribution of *Culex tarsalis* Coq., which extends throughout the great plains,

prairies and western irrigated areas, is reviewed in detail. It corresponds well with the range of a severe epizootic of western equine encephalomyelitis in horses that occurred in 1941. *C. tarsalis* has been found naturally infected with the virus of this disease in Washington, California, Nebraska, Minnesota, North Dakota and Manitoba. Between 1942 and 1946, its known distribution was extended 500 miles eastward to South Carolina. It may have been discovered in this area because of intensified collecting or it may have been introduced through increased traffic. It is most abundant in the western states. The peak of adult abundance occurs in July and August in the west, but towards the east it occurs progressively later, and in the south-east, adults are found only in late autumn and winter. Both wild and domestic animals are attacked, but man is not an important host. Feeding takes place at dusk and at night. The larvae breed in a large variety of habitats and under a wide range of conditions.

WORTH (C. B.). **House Mice and commensal Rats in Relation to the Dissemination of Rat Fleas.**—*Amer. J. trop. Med.* **30** no. 6 pp. 917–920, 8 refs. Baltimore, Md., 1950.

During routine rearing of *Xenopsylla cheopis* (Roths.) on white mice (*Mus musculus*) at Tampa (Florida), it was observed that the mice were not infested to the same degree as roof rats (*Rattus rattus*) on which the fleas were periodically fed, and the difference in infestation was further examined in view of its possible bearing on the epidemiology of diseases of commensal rodents. When white mice were exposed to fleas in suitable containers, few fleas could be found on a mouse at any one time, but many could be recovered from the bedding. When rats were exposed, most of the fleas remained continuously on them, and only a few could be found in the bedding. House mice trapped at Tampa differed little from the white mice or among themselves as to the numbers of fleas they would tolerate, but some of them merely rid themselves of the fleas, while others killed them. When 200 fleas were applied to mice in a partitioned cage containing 11 house mice on one side of a double hardwear cloth screen and two rats on the other, 37 were recovered a week later from the rats, 1 from a mouse and 157 were in the bedding, principally in the mouse compartment. After two rats, 11 house mice and 100 fleas had been in the same compartment for 24 hours, 46 fleas were found on the rats, 3 on mice and 51 on bedding. It is apparent from these results that house mice are not favourable hosts for *X. cheopis*, probably on account of their short hair and active grooming. Most of the house mice trapped for the experiments were free of ectoparasites and none harboured *X. cheopis*. Evidence is given suggesting that mice may be intolerant of other ectoparasites also. Results of surveys of murine typhus in house mice in various countries are quoted indicating low rates of infection in them. The observations reported suggest that specific host-parasite relationships may minimise the transmission of murine typhus in populations of mice.

[FEDYUSHIN (A. V.).] **Федюшин (А. В.). The Rôle of Pasture Management in the Control of Ticks and tick-borne Diseases of Man and agricultural Animals.** [*In Russian.*]—*Zool. Zh.* **28** pt. 6 pp. 485–494, 20 refs. Moscow, 1949.

Investigations were carried out near Omsk in the forest-steppe zone of western Siberia in 1939 and 1940 to ascertain the effect of pasture improvement on *Dermacentor marginatus* (Sulz.) and *D. pictus* (Herm.) [*cf. R.A.E.*, B **24** 299]. The improved pastures, which are maintained for about five years in a programme of crop rotation, are established by sowing grass on ploughed land and are harrowed periodically. The ticks were collected on cattle and rodents and

by drags from the ground, in natural pastures in woodland and in improved pastures that were in their fifth year of growth, had a few clumps of trees in them and had been used for grazing for three years. The results showed that *D. marginatus* and *D. pictus* both occurred in the improved pastures, but were far less numerous than in the natural ones. The average and (in brackets) maximum numbers of ticks per head on cattle in the improved and natural pastures were 0·13 (3) and 4·6 (33), respectively, in September 1939, and 0·02 (1) and 1–3·2 (45) in May 1940. The numbers of rodents present and the percentages of them infested by larvae and nymphs of the ticks were also far smaller in the improved pastures and hardly any ticks were collected by drags in them.

The individual stages of both ticks were completed more rapidly in the open improved pastures than in the shady forest ones. Special field experiments begun in September 1939 with engorged females of each species showed that considerable percentages survived the winter in the improved pastures, sheltering in the tufts of grass or tillering nodes, though *D. pictus* was the more resistant. Temperatures were rather above normal except in January when the minimum was −42°C. [−43·6°F.]. When the ticks were exposed on a plot that had been ploughed and was devoid of vegetation, winter mortality was complete and the dead ticks were found in the upper 2 ins. of the soil.

The survival of unfed ticks after ploughing was found to be in inverse proportion to the ploughing depth and the humidity of the soil. Thus, 58 per cent. had made their way to the surface 22–55 days after ploughing to a depth of 2–4 ins. in soil that contained not more than 10–20 per cent. moisture, as compared with 27·5 per cent. when the ploughing was 6–8 ins. deep. In soil with 50 per cent. moisture, less than half the ticks regained the surface when the ploughing depth was 2–4 ins., and none did so in soil of any humidity when it was 10 ins.

[Pervomaĭskiĭ (G. S.).] **Первомайский (Г. С.). Parthenogenetic Development in Ticks of the Family Ixodidae.** [*In Russian.*]—*Zool. Zh.* **28** pt. 6 pp. 523–526, 1 fig., 5 refs. Moscow, 1949.

Since little is known of parthenogenesis in Ixodid ticks, experiments were carried out in the Soviet Union with *Hyalomma marginatum marginatum* Koch, *H. m. turanicum* Pom., *H. anatolicum excavatum* Koch, and *H. dromedarii* Koch. The ticks were isolated as engorged nymphs, and the resulting females were allowed to feed on rabbits and then isolated for oviposition. Not all the females engorged in the absence of males, and though those that did so laid numerous eggs, very few of these hatched. The progeny nearly all died in the larval or nymphal stages, but a few adults, all females, were obtained in the case of *H. a. excavatum*. Observations on these were to be continued.

[Skuf'in (K. V.).] **Скуфьин (К. В.). Materials relating to the Investigation of the Breeding Places of Horseflies (Tabanidae) in the Environs of Voronezh.** [*In Russian.*]—*Zool. Zh.* **28** pt. 6 pp. 527–534, 4 refs. Moscow, 1949.

The investigations described were carried out in 1947–48 in swamps and pools along the banks of a stretch of river in a pine forest near Voronezh. Larvae and pupae of Tabanids were found in samples of soil taken from these sites in April and May. The larvae were very scattered and were not numerous, even in places in which worms and insects on which they might feed were abundant. This, and the fact that they were very mobile in the laboratory, indicated that they are capable of migrating for considerable distances [*cf. R.A.E.*, B **24** 302]. Only a few of the larvae gave rise to adults, and these proved to be *Tabanus bovinus* L. and *T. tropicus* Panz., but practically all the pupae did so, the adults being *T. tropicus*. Eggs were collected in June,

July and August from the leaves and stems of various plants rising above the surface of the water or growing at the edges. They occurred chiefly over shallow water and were rare on the banks, but a few were found on reeds in a swamp that had dried up. The species involved were not known, but most were *Chrysops relicta* Mg., the females of which were repeatedly observed ovipositing. The eggs were parasitised by *Telenomus tabani* Mayr and *Trichogramma evanescens* Westw.

FIEDLER (O. G. H.). **Die Nahrung der Myiasis-Fliegenlarven auf dem Wollschaf.** [The Nutrition of Blowfly Larvae on Sheep.]—*Z. angew. Ent.* **33** pt. 1–2 pp. 142–150, 2 figs., 7 refs. Berlin, 1951.

Lucilia cuprina (Wied.) is much the most important primary sheep blowfly in South Africa, though *Chrysomyia chloropyga* (Wied.) is responsible for primary infestation in a small minority of cases. *C. albiceps* (Wied.) is the commonest of the species that do not themselves cause wounds but infest those produced by the primary flies. *L. sericata* (Mg.) is restricted to carrion in South Africa, and references to it on sheep in the literature there are based on confusion with *L. cuprina* [*cf. R.A.E.*, B **33** 6 ; **40** 184, 186].

The factors that render merino sheep liable to blowfly infestation are reviewed, and the types of myiasis characteristic of primary and secondary infestations are described. Investigations showed that the digestive juices of the larvae of *L. cuprina* contain proteolytic enzymes that rapidly dissolve the epidermal cells and sometimes also the outer cell layers of the corium, setting up an inflammation that results in excessive exudation of lymph. The wounds remain open and necrosis sets in. Most of the larvae are usually found a little distance from the skin, in fleece that is wet with lymph, whereas larvae of *C. albiceps* are normally found on the wound itself.

In laboratory experiments, young larvae of *L. cuprina*, *C. chloropyga* and *C. albiceps* were fed on fresh meat, serum or blood and their weights compared after three days. All species thrived best on meat. The increases in weight were smaller for serum, though *L. cuprina* developed fairly well on it, and blood was inadequate for all species, though least so for *L. cuprina*. Sheep were then artificially infested by a modification of the method described by Macleod [**26** 25], a small wound being scratched on the skin, and the weights of the larvae after three days were compared with those obtained in the laboratory. The results were about the same as for serum in the case of *L. cuprina* and *C. chloropyga* and as for fresh meat in that of *C. albiceps*. It is concluded that the larvae of *C. albiceps* feed mainly on the tissues, and those of *L. cuprina* mainly on lymph, and that the degree of adaptation to the latter food is a measure of the ability of the two primary species to establish themselves on healthy sheep. In further laboratory tests, newly-emerged larvae of *L. cuprina* and *C. chloropyga* were unable to feed and grow normally on clean or soiled wool moistened with distilled water, whether freshly cut or soaked for four days in rain-water. It is concluded that the newly-hatched larvae make their way directly to the skin of the sheep, where their communal activity produces the flow of lymph on which they feed.

KEMPER (H.) & HABENICHT (G.). **Erfahrungen mit der kommunal gelenkten Wanzenbekämpfung in Berlin.** [Experience with communally directed Control of the Bed-bug in Berlin.]—*Z. angew. Ent.* **33** pt. 1–2 pp. 282–296, 1 map, 2 refs. Berlin, 1951.

An account is given of the organisation and progress of a campaign for the control of bed-bugs [*Cimex lectularius* L.] in Berlin. A preliminary statistical survey was carried out in 1948 in the whole city to ascertain the

degree and distribution of infestation, and it was made compulsory for the occupants of private houses to declare cases of infestation. In October–November, infested public buildings in all districts and private houses in the most heavily infested central district were sprayed with DDT by, or under the supervision of, trained personnel. Subsequent operations had to be restricted to West Berlin, and 13,171 buildings were treated there in 1949 and 7,523 in 1950, when BHC sprays were used in addition to DDT. Treatment was repeated after three weeks in the very few buildings in which one application was insufficient. Although the number of cases of infestation declared by the population was considerably below that calculated from the results of the survey, the authors give reasons for assuming that the measures adopted halved the infestation in West Berlin. The work was to be continued.

WIESMANN (R.) & KOCHER (C.). **Untersuchungen über ein neues, gegen resistente *Musca domestica* L. wirksames Insektizid.** [Investigations on a new Insecticide effective against resistant Strains of *M. domestica*.]—*Z. angew. Ent.* **33** pt. 1–2 pp. 297–321, 7 figs., 28 refs. Berlin, 1951.

An account is given of investigations on 1-phenyl-3-methyl-pyrazolyl-(5)-dimethylcarbamate, a urethane referred to as Pyrolan or G.22008 that was synthesised in Switzerland during work on the control of strains of *Musca domestica* L. resistant to DDT. It is a crystalline substance that melts at 50°C. [122°F.], is soluble in most organic solvents and has a solubility of 0·1 per cent. in water at 20°C. [68°F.]. It has hydrophilic and lipophilic properties, but is only slightly absorbed through the skin. The median lethal doses for rats and mice *per os* were 62 and 90 mg. per kg., respectively, so that its toxicity to these animals is about the same as that of rotenone.

Studies on its general insecticidal properties showed that Pyrolan was not toxic to Lepidopterous larvae, nymphs of *Periplaneta* (*Blatta*) *americana* (L.) or adults of *Melolontha melolontha* (L.) that ingested it, but was toxic *per os* to insects that feed on liquids, the median lethal doses in mg. per kg. being 24 and 0·5 for adults of *Autographa* (*Plusia*) *gamma* (L.) and *Ephestia kuehniella* Zell., respectively, 13 for honey bees and 3·2 for adults of *Musca domestica*. Its toxic effect was rapid, a dose of 0·5 mmg. per fly causing complete knock-down and mortality in 14 minutes and 24 hours, respectively, of adults of a strain of *M. domestica* fairly resistant to DDT ; lower doses also caused knock-down, but some of the flies recovered from it. It was toxic by contact to insects of several orders exposed to deposits of 1 mg. or less per 100 sq. cm. from acetone solutions, the periods of continuous exposure to 1 mg. giving complete knockdown being 30 and 10 minutes for adults and larvae of the resistant *M. domestica*, 24 hours for *Cimex lectularius* L. and a tick (*Ornithodoros*), 72 hours for *Calandra granaria* (L.), and 42 minutes for *Aphis rumicis* L.; it was not toxic to *P. americana* at that rate, but caused complete knockdown in 9 hours at 10 mg. per 100 sq. cm., and was ineffective against larvae of *E. kuehniella* and *Tenebrio molitor* L. The concentrations in water required for 50 per cent. kill of larvae of *Aëdes aegypti* (L.) and Trichoptera were 3,000 and 3 parts per million, respectively.

The symptoms of poisoning were characteristic and independent of method of application. Affected insects lay on their backs and showed recurrent tremors of the extended extremities, accompanied by movements of the mouth-parts and oesophagus leading to swallowing of air [*cf. R.A.E.*, A **40** 360].

In investigations on the site and mode of action, in which *P. americana* was the test insect, decapitation before or after treatment did not reduce the tremors in cockroaches into which Pyrolan was injected, and injection into the head capsule or the cerebral and suboesophageal ganglia caused movements of the mouth-parts only, so that the brain was apparently not the site of toxic

action. Topical application of a 0·1 per cent. aqueous solution of Pyrolan to the exposed thoracic ganglia caused typical tremors of the extremities, and these continued when the longitudinal connectives were severed and were merely altered in rhythm when the thoracic segments were dissected from the body. Treatment of the ganglia with 2·5 per cent. barbituric acid following treatment with Pyrolan reduced or suppressed the tremors, and Pyrolan applied to ganglia previously treated with barbituric acid reversed the paralytic effect of the latter. Treatment of a thoracic ganglion with nicotine suppressed the tremors in the corresponding extremities but not in the other pairs. Injection of a mixture of Pyrolan and DDT caused tremors typical of both, and subsequent treatment of the ganglia with nicotine suppressed the Pyrolan component but had only a slightly weakening effect on the DDT symptoms. When the leg-nerves of cockroaches affected by Pyrolan were severed close to the ganglia, the tremors ceased at once. It is concluded that tremors occur only in the presence of an intact reflex arc, and that unlike DDT [*cf.* A **38** 233], Pyrolan acts centrally on the motor region of the ganglia.

In tests on the transport of Pyrolan in the body, topical application to the exposed lowest abdominal ganglion did not cause tremors of the extremities, but the cerci were affected, and injection of Pyrolan solution into the left fore-leg caused tremors in that leg in about five minutes, in the right fore-leg in 8–10 minutes, in the second pair in 40–50 minutes, and in the hind pair in 55–60 minutes. When the longitudinal connectives of the thoracic ganglia were severed, the tremors ceased in the hind legs after 4–6 minutes and then in the middle pair, whereas they persisted for an hour in the fore-legs. It thus appears that Pyrolan is transported in the endoneural lymph canals over only short distances. It apparently penetrates into the ganglia, since washing in water following its topical application to them had no effect. Injection of 0·05 cc. of a 0·1 per cent. aqueous solution of Pyrolan into the abdominal part of the heart caused no toxic symptoms, but blood taken after 15 minutes from insects so treated was toxic to *M. domestica*. Blood taken after an hour was not toxic, so that Pyrolan is apparently rapidly decomposed in insect blood. Further bioassay with *M. domestica* showed that Pyrolan was present in the organs of cockroach nymphs 2–4 hours after they had been knocked down by contact with a deposit. Pyrolan increased respiration, carbon-dioxide production and water loss in treated insects, and slightly increased the acidity of the blood and muscles, probably as a result of lactic-acid production. Death appeared to be due to exhaustion combined with autointoxication.

The further work described was carried out with a view to the use of Pyrolan against DDT-resistant strains of *M. domestica*. In laboratory tests, resistant flies were exposed in containers with a capacity of 20 litres to 0·5 cc. of 0·5–5 per cent. solutions of Pyrolan in a petroleum-oil solvent released in the form of an aerosol. The average periods before 50 per cent. permanent knockdown occurred ranged from 15·5 and 26·5 minutes for 0·5 per cent. Pyrolan solutions to 5·5 and 7 minutes for 5 per cent. at 23–27 and 16–20°C. [73·4–80·6 and 60·8–68°F.], respectively, as compared with over an hour for 5 per cent. DDT at both temperatures. When DDT-susceptible flies were treated by the same technique at 18–21°C. [64·4–69·8°F.], the periods ranged from 22·5 to 6 minutes for 0·5–5 per cent. Pyrolan and from 30 to 11·5 minutes for DDT at the same concentrations ; they were 7·5 minutes for 2 per cent. Pyrolan and 15 minutes for 4 per cent. DDT. In the spring of 1950, resistant flies were released in rooms that had been sprayed with 5 per cent. DDT alone or mixed with Pyrolan at 3 cc. spray per sq. metre. Knockdown was complete in 20, 15 and 15 minutes for DDT with 0·25, 0·5 and 1 per cent. Pyrolan, respectively, and was only 83 per cent. for DDT alone after 30 minutes. The temperature was 19°C. [66·2°F.]. When Pyrolan was applied in the petroleum solvent to glass and wood at 0·12–0·6 gm. per sq. metre, the deposits remained toxic to resistant

flies for 28 days. those on glass being the more effective. Exposure to deposits of 0·5 gm. per sq. metre from kerosene solution on glass showed that flies resistant to DDT reacted somewhat more slowly to Pyrolan than did susceptible ones, the percentages knocked down after an hour being 82–95 and 100, respectively. Since this suggested that resistance to Pyrolan might be developed by repeated treatment, a strain of DDT-susceptible flies was exposed for one minute in each generation to a Pyrolan deposit giving 30–70 per cent. mortality. No resistance to Pyrolan or DDT had appeared by the ninth generation. When a DDT-resistant strain was similarly treated, its susceptibility to Pyrolan had not changed and its resistance to DDT was only very slightly reduced by the 18th generation.

In field tests in 1950 against mixed populations of *M. domestica*, a spray of 5 per cent. DDT with 2 per cent. Pyrolan in kerosene was applied at about 15 cc. per sq. metre to the walls of rooms in an establishment in Berne in which DDT alone had proved ineffective. The rooms were free from flies after five days and still free after two months, and large numbers of dead flies were found on the floors. The two materials at the same concentrations were also applied at 20–50 cc. spray per sq. metre in houses in Sardinia against resistant flies, and effective control was obtained for three months.

Pyrolan also proved effective in laboratory tests against larvae of resistant *M. domestica*, 0·1–0·5 per cent. solutions in a mixture of water and alcohol (10 : 1) added to the rearing medium in the proportion of 1 : 60 by volume giving complete or almost complete mortality in ten days of larvae ready to pupate that were then placed in it. Subsequent tests showed that younger larvae were more susceptible to Pyrolan than older ones.

Incho (H. H.) & Greenberg (H.). **Synergistic Effect of Piperonyl Butoxide with the active Principles of Pyrethrum and with Allethrolone Esters of Chrysanthemum Acids.**—*J. econ. Ent.* **45** no. 5 pp. 794–799, 5 graphs, 16 refs. Menasha, Wis., 1952.

Although definite synergism has been demonstrated for combinations of piperonyl butoxide and allethrin [*R.A.E.*, B **40** 59], these combinations have been found to be only about one-third as effective against *Musca domestica* L. as the equivalent combinations of piperonyl butoxide and natural pyrethrins (the mixture of pyrethrins and cinerins present in pyrethrum extract). In previous studies of the active components of natural pyrethrum alone on *M. domestica*, it has been shown that the monocarboxylic or type I compounds are definitely superior to the dicarboxylic or type II compounds [**37** 67, 155]. Tests of allethrolone [*dl*-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one] esterified with certain chrysanthemum monocarboxylic acid isomers have also shown that the ester of the natural acid has insecticidal activity of a high order and have indicated that the completely synthetic ester (allethrin) is almost twice as effective as natural pyrethrins [*cf.* **39** 25, etc.].

An account is given of studies undertaken to determine whether any one of the separated active components of pyrethrum might account for the high synergistic activity of natural pyrethrins when mixed with piperonyl butoxide and also to indicate whether changes in optical or geometric configuration might alter synergistic effect. Tests were made on *M. domestica* by the turntable method [**26** 246]. The ester and piperonyl butoxide were used in the ratio 1 : 10. All results are based on the median lethal dose.

The whole of the synergistic factor in pyrethrum extract was shown to be present in the highly purified natural pyrethrins fraction that was the standard for the tests. By the use of a value representing relative synergistic effect, the cinerins were shown to exhibit a somewhat greater degree of synergism with piperonyl butoxide than did the pyrethrins, although pyrethrin I and II were

more effective than the corresponding cinerins when used alone or when both were mixed with piperonyl butoxide. None of the separated active components showed greater synergistic activity than the standard extract. It is concluded from this that no one of the components contributed the major portion of the synergism found with mixtures of piperonyl butoxide and natural pyrethrins. Pyrethrin I was superior to the standard extract when used alone, but was equal to the standard when both were mixed with piperonyl butoxide. Cinerin I, pyrethrin II and cinerin II were 79, 67 and 45 per cent. as effective as the standard when all four were tested alone, and 74, 40 and 35 per cent. as effective when all four were tested with piperonyl butoxide.

It is generally believed that the ratio of pyrethrins to cinerins in pyrethrum extract is about 70 : 30 and that the ratio of the type I to type II compounds is 50 : 50. When mixtures of pairs of the individual components in the respective ratios and of all four were compared with the standard, all in combination with piperonyl butoxide, pyrethrin I and cinerin I, pyrethrin I and pyrethrin II, cinerin I and cinerin II, pyrethrin II and cinerin II and the complete mixture were 96, 86, 71, 33 and 79 per cent. as effective, respectively.

Allethrin and the *dl-trans* and *dl-cis* monocarboxylic acid esters of allethrolone were 2·16, 2·59 and 1·08 times as effective as the standard extract, and the natural *d-trans* mono-acid ester was 4·12 times as effective. The natural dicarboxylic acid ester was only 75 per cent. as effective as the standard. In combination with piperonyl butoxide, these esters retained the same general order of effectiveness among themselves but all were much less effective than the piperonyl butoxide and pyrethrins standard. Thus, although optical and geometric isomerism in the acid portion of the molecule have a marked influence on the insecticidal effectiveness of allethrolone esters of chrysanthemum monocarboxylic acid, when these esters are used alone or in combination with piperonyl butoxide, they have little effect on comparative synergistic activity.

Smith (C. N.), Cole (M. M.), Lloyd (G. W.) & Selhime (A.). **Mosquito-repellent Mixtures.**—*J. econ. Ent.* **45** no. 5 pp. 805–809, 5 refs. Menasha, Wis., 1952.

Extensive tests of repellents against mosquitos showed that mixtures are effective against a wider range of species than any single chemical compound and led to the adoption by the U.S. armed forces of the 6 : 2 : 2 mixture of dimethyl phthalate, 2-ethyl-1,3-hexanediol and Indalone [*R.A.E.*, B **39** 169]. Results are given of continued studies designed to find a more generally effective mixture. The four most effective against several species of *Aëdes* comprised 4 parts dimethyl phthalate and 3 parts 2-ethyl-1,3-hexanediol with 3 parts either dimethyl carbate or propyl N,N-diethylsuccinamate [*cf.* **39** 4, 133] ; equal parts of 2-ethyl-1,3-hexanediol and o-chloro-N,N-diethylbenzamide ; and 4 parts 2-ethyl-1,3-hexanediol, 3 parts o-chloro-N,N-diethylbenzamide and 3 parts propyl N,N-diethylsuccinamate.

The last mixture and a few others proved relatively ineffective in a test against *Anopheles quadrimaculatus* Say.

Krusé (C. W.), Hawkins (W. B.) & Ludvik (G. F.). **Resistance of *Anopheles quadrimaculatus* to DDT in the Tennessee Valley.**—*J. econ. Ent.* **45** no. 5 pp. 810–814, 2 graphs, 9 refs. Menasha, Wis., 1952.

It is a routine practice of the Tennessee Valley Authority to check the effectiveness of DDT sprays or aerosols applied from aircraft for the control of larvae of *Anopheles quadrimaculatus* Say by sampling the amounts of DDT

deposited and by exposing fourth-instar larvae of an insectary strain in containers at various distances from the line of flight. Comparisons of data obtained in this way showed that the amounts of DDT needed for 50 per cent. kill (LD50), expressed as mmg. available per larva, were 10 and 25 times as great in 1950 and 1951, respectively, as in 1949. The mean amount of DDT per acre needed for complete kill of the test larvae increased from less than 0·002 lb. per acre in 1946–49 to about 0·017 in 1950 and 0·024 in 1951. Aerosols were replaced by sprays as larvicides for application from aircraft in 1948 [*cf. R.A.E.*, B **41** 54–55]. The difference observed in their effectiveness could not be explained on the basis of number of droplets recovered, particle size or solvent. It was not until the data were separated by seasons that development of a strain of mosquitos resistant to DDT was suspected. It is not clear how the insectary-reared mosquitos developed resistance to DDT, but the strain was often reinforced with wild-caught individuals. The increase in dosage of DDT needed to control larvae of *A. quadrimaculatus* was associated with the increased use of chlorinated hydrocarbons for the control of cotton pests rather than with the direct use of DDT for mosquito control.

Data from field tests carried out against a natural population of *A. quadrimaculatus* in Tennessee showed that it was necessary in 1951 to double the rate of application of DDT distributed by aircraft in order to obtain results as satisfactory as during previous years. Consideration of the results of various laboratory tests in which larvae of this mosquito were exposed to DDT by several methods shows that LD50 values had increased some 20 times in 1951 as compared with 1945. Many factors affect the results of such tests [*cf.* **41** 41], but an empirical method is presented of correlating data obtained through various testing procedures in which there are differences in volume and surface area of water, number of larvae, and amount of DDT in oil solution, emulsified solution or suspension so that the dosages are expressed in mmg. p,p'DDT available per larva.

Muma (M. H.), Hill (R. E.), Hixson (E.) & Harris (L.). **Control of Sheep-ticks on Feeder Lambs.**—*J. econ. Ent.* **45** no. 5 pp. 833–838, 31 refs. Menasha, Wis., 1952.

In the course of experiments in Nebraska in 1947–51 on the effect of infestation by *Melophagus ovinus* (L.) on the weight of lambs fed on a standard grain mixture and on methods for its control, it was established that an adequate estimation of infestation could be made by counting adults and viable pupae in ten evenly spaced 12-inch partings of the wool on each side of the animals. No significant differences were demonstrated in the weight gained by infested and uninfested lambs. The treatments tested for control comprised a dip of 2 lb. DDT and 10 lb. sulphur in 100 U.S. gals. water, a dust of 5 per cent. cubé in sulphur, and sprays containing DDT, cubé and sulphur and mixtures of sulphur with cubé or DDT. Most of the spray mixtures were applied by crowding the lambs in a small pen and thoroughly spraying the backs, sides and as much of the underline as possible at 250–300 lb. pressure [*cf. R.A.E.*, B **40** 59], and the results of this method of application were poor and inconsistent, so that comparison between the insecticides was impossible. A spray of 6 oz. cubé in 100 U.S. gals water and the DDT-sulphur mixture used for the dip were also applied by ribbon spraying (spraying the head, neck and mid-line of the back at 400 lb. pressure), and both reduced infestation considerably but failed to give lasting control. The dust was about as effective as these sprays after 30 days and considerably more so after 156 days, but was much less effective than the dip, which gave complete or almost complete eradication.

GERSDORFF (W. A.) & MITLIN (N.). **Relative Toxicity of Furethrin, its natural Acid Isomer, and Pyrethrins to House Flies.**—*J. econ. Ent.* **45** no. 5 pp. 849–850, 3 refs. Menasha, Wis., 1952.

A Japanese sample of furethrin [*R.A.E.*, B **41** 47], an almost pure sample prepared by the Bureau of Entomology and Plant Quarantine and a practically pure sample of furethrin isomer formed from the natural *d-trans*-chrysanthemum monocarboxylic acid were compared with pyrethrins (52 per cent. pyrethrin I and cinerin I) in kerosene sprays by the turntable method [**26** 246] against *Musca domestica* L. The Japanese sample of furethrin was either less pure when prepared than the Bureau's or had deteriorated in transit. Knockdown was complete for all sprays. The pyrethrins gave 93·5, 77·6, 42·4 and 22·8 per cent. mortality in one day at 8, 4, 2 and 1 mg. per ml., respectively, the corresponding figures being 94, 79·1, 52·4 and 23·5 for the Bureau's sample of furethrin and 84·4, 57·9, 35·5 and 19·8 for the Japanese sample. The *d-trans* acid isomer was nearly twice as toxic as the Bureau's furethrin, the mortality percentages given by 4, 2, 1 and 0·5 mg. per ml. being 90·5, 70·3, 47·3 and 23·6. This is the same ratio of toxicity as that found for analogous esters with a similar configurational relationship when the cyclopentenolone component contained the allyl instead of the furfuryl side chain [**39** 25 ; **41** 72].

MARCH (R. B.), METCALF (R. L.) & LEWALLEN (L. L.). **Synergists for DDT against Insecticide-resistant House Flies.**—*J. econ. Ent.* **45** no. 5 pp. 851–860, 13 refs. Menasha, Wis., 1952.

Strains of the house-fly [*Musca domestica* L.] that are not controlled by deposits of the insecticides in general use have developed in many parts of southern California [*cf. R.A.E.*, B **40** 14]. To investigate the possibility of activating the insecticides against the resistant strains, 96 compounds, structurally related to DDT, were compared as synergists for it against resistant flies. Synergistic activity was evaluated by applying drops (1 cu. mm.) of acetone solutions containing 5 per cent. weight in volume DDT and 1 per cent. synergist (50 mmg. DDT and 10 mmg. synergist) to 20 individual female flies of the Super-Pollard strain (developed from the Pollard strain [*loc. cit.*, etc.] by further selection with BHC as lindane). The 16 combinations that gave 90 per cent. mortality or more compared with 20 per cent. for 50 mmg. DDT alone were then tested at lower doses, the DDT-synergist ratio being maintained at 5 : 1. The dosage-mortality data thus obtained are shown in a table, and a list is given of the 96 compounds showing their relative synergistic activity when combined with DDT at 1 : 5, as compared with an activity of 1 for DDT alone. Four of the compounds had activities of 100 or more. These were bis(p-chlorophenyl)chloromethane, 1,1-bis(p-chlorophenyl)ethane and two samples of bis(p-chlorophenyl) ethynyl carbinol, which had activities of 140, 100, 160 and 100, respectively.

Certain structural characteristics necessary for synergistic action are apparent. There is an association of the bis(p-chlorophenyl) structure with synergistic activity, and the central aliphatic group that links the two p-chlorophenyl groups is even more important. The simple aliphatic-linked series shows maximum activity with the 1,1-ethane linkage, compared with the methane or unsaturated 1,1-ethylene linkages. In the series with alcoholic groups, maximum activity is found in the ethynyl carbinol linkage. Among the compounds in this series with saturated central linking groups, maximum activity (60) is shown by the methyl carbinol. Only two of the 96 compounds, neither of which had any great synergistic action, showed appreciable toxicity at 10 mmg. per fly when used alone.

The effect of varying the ratio of synergist to DDT was determined for the best four synergists, and dosage-mortality data for various ratios from 1 : 100 to 10 : 1 are given in a table. Activity increased in all cases as the ratio of synergist to DDT increased, but even with a 10 : 1 combination, DDT was not reactivated against resistant flies to its original activity against susceptible flies. Results of separate applications of DDT and bis(p-chlorophenyl)chloromethane or 1,1-bis(p-chlorophenyl)ethane at various intervals are shown in another table. Synergistic activity was evident when either DDT or synergist was applied up to 24 hours after the other. When the synergist was applied first, mortalities decreased progressively as the interval between the applications increased, but this decrease was not evident when the order of application was reversed. The synergistic effects of bis(p-chlorophenyl)chloromethane, 1,1-bis(p-chlorophenyl)ethane and the two samples of bis(p-chlorophenyl) ethynyl carbinol with p,p'methoxy-DDT (methoxychlor) were also studied, and dosage-mortality data for graded quantities of methoxy-DDT and synergist in a constant 5 : 1 ratio and for 0·3 mmg. methoxy-DDT per female fly with varying amounts of synergist are given. Methoxy-DDT is more toxic than DDT to the Super-Pollard strain but the effect of the synergists on it was less than on DDT, though similar. Bis(p-chlorophenyl)chloromethane and bis(p-chlorophenyl) ethynyl carbinol decreased the activity of DDT against a susceptible strain [*cf.* **40** 55].

Data are given on the comparative effects of deposits from acetone solutions on filter paper of DDT or methoxy-DDT (200 mg. per sq. ft.) alone or with each of the best synergistic compounds (40 mg. per sq. ft.) on susceptible and resistant flies, in terms of the exposure periods needed for 50 per cent. knockdown and for 50 per cent. mortality in 24 hours. In general, the synergists made the DDT and methoxy-DDT about as effective in causing knockdown of resistant flies as they were alone in causing knockdown of susceptible flies. The resistant flies, however, needed 2–6 times as long an exposure to the combinations for 50 per cent. mortality as the susceptible flies needed with DDT or methoxy-DDT alone. Three hours' exposure of resistant flies to DDT or methoxy-DDT alone caused no appreciable mortality, though half the flies were knocked down.

The best four synergists were tested on two pig ranches and in two dairies against flies that were highly resistant to DDT and somewhat resistant to methoxy-DDT and lindane. Combinations of DDT, methoxy-DDT and the synergists were normally formulated as xylene emulsion concentrates, and spray was applied under high pressure until run-off to all accessible surfaces on which flies were likely to rest. The period of effective control ranged from 2 to 8 weeks. These results were in general as good as or better than any obtained since the development of resistance of the combined DDT-lindane type.

An experiment in which larvae and adults of the DDT-resistant Bellflower strain [**40** 14] were subjected to increasing doses of DDT and 1,1-bis(p-chlorophenyl)ethane, in such concentrations that 20–40 per cent. of the adults survived to maintain the strain, showed that in five generations resistance had developed approximately to the level of that present for DDT alone before selection. Tests with DDT and the other good synergists against this resistant strain showed that high levels of resistance had developed to these combinations also.

Spear (P. J.) & Sweetman (H. L.). **Continuous Vaporization of Insecticides with special Reference to DDT.**—*J. econ. Ent.* **45** no. 5 pp. 869–873, 1 graph, 7 refs. Menasha, Wis., 1952.

Continuous vaporisation of DDT or other insecticides by heat provides an effective method of controlling various insects in enclosed spaces such as houses, restaurants, animal quarters or stores [*cf. R.A.E.*, B **39** 139 ; **40** 43 ; **41** 42 ;

A **40** 85, 122]. The method, which has been under investigation at the University of Massachusetts since 1947, is rapidly effective against house-flies [*Musca domestica* L.] and mosquitos, but also serves to prevent, or gradually eradicate, infestation by such pests as silverfish, cockroaches or carpet beetles. It involves no disruption of activities in the room treated, no diluent is employed, so that the stains and odours common after spray applications and the dust deposits from dry applications are eliminated, the odour is negligible if the insecticides are properly chosen and used, and the process is economical in both material and labour, but skill and experience are required in choosing a position for the vaporising apparatus, the breakdown of insecticides due to accidental introduction of contaminants may result in bad odours and loss of insecticidal activity, vaporisers are subject to mechanical defects, insecticides of high purity are required, and accurate control of rates of vaporisation must be maintained under diverse physical conditions. Thus well designed vaporisers equipped with thermostats of high quality are required. Some of those produced commercially are briefly discussed.

The accepted rate of vaporisation of insecticides in the United States is 1 gm. per 15,000–25,000 cu. ft. per day. DDT is not at present widely employed in vaporisers used for house-fly control, because of the occurrence of strains of the fly resistant to it, but it readily controls other household pests and those that infest stored products. Owing to the low vapour pressure of p,p'DDT, little remains in the vaporised state at room temperatures, and when it is vaporised by heat at 1 gm. per 20,000 cu. ft. per day, it condenses into droplets, most of which are less than 12 microns in diameter, as soon as it leaves the vaporiser and reaches the cooler air. These droplets persist for up to 4–5 days and then form fine needle-like crystals that remain for several months before subliming. An inhibitor of breakdown is required when DDT is subjected to heat for long periods of time, as in vaporisation. The aerosol formed by the vaporisation of DDT diffuses rapidly. Tests with house-flies indicated that its concentration is initially greater in the upper part of the enclosed still air, but that after some time, it becomes greater in the lower part ; all or nearly all the DDT deposited as a residue from the aerosol falls from still air on to horizontal surfaces. However, under normal conditions of ventilation, the droplets remain airborne for long periods, and probably only a small proportion finally settles on the floor.

A method of suspending house-flies from threads so that they could be exposed to an airborne insecticide but could not come in contact with any surface deposit was devised during the investigation. Nylon thread was used, as its tip could be fused in a flame to make a tiny ball. The ball was coated with melted beeswax and placed against the protergum of an anaesthetised fly. The fly was not apparently injured, and when suspended could fly in circles but could not lift enough thread to touch any surface.

Fox (I.). **Light Trap Studies on *Culicoides* in Puerto Rico.**—*J. econ. Ent.* **45** no. 5 pp. 888–889, 7 refs. Menasha, Wis., 1952.

Catches in two New Jersey light-traps operated at a barracks near Cayey, Porto Rico, on 975 and 960 nights between 1st July 1949 and 30th April 1952 included, respectively, 963 and 16,977 individuals of five species of *Culicoides* [*cf. R.A.E.*, B **40** 55], of which 900 and 16,837 were *C. inamollae* Fox & Hoffman. The traps were about one mile apart. It is inferred that the second trap was near a breeding area and that the flight range is in general less than one mile. The average number of individuals of *C. inamollae* per trap night per month in the second trap is shown in a table. The data indicate that this species was usually plentiful from October to March and scarce from April to September.

KNUTSON (H.). **A Community Project for Control of the American Dog Tick.**—*J. econ. Ent.* **45** no. 5 pp. 889–890. Menasha, Wis., 1952.

An experiment in the control of *Dermacentor variabilis* (Say) by community effort with practically no professional supervision was made on Jamestown, an island in the State of Rhode Island, in 1951. A spray containing 8 lb. 50 per cent. DDT wettable powder per 100 U.S. gals. water was applied on 8th June at 4 lb. DDT per acre to a strip 6–8 ft. wide bordering several miles of roads and paths. Counts of ticks were made professionally 2–4 days before spraying and 4 days after it. The numbers of ticks caught per 100 paces, averaged from three methods (sweeping with a net and collection from the trousers and on a drag), were 1·13 before spraying and 0·02 after it at 12 stations in areas that were sprayed and 1·30 before spraying and 0·4 after it at 11 stations in an area that was not sprayed. An appreciable natural reduction was also apparent in other areas of the State at the same time but had never before been recorded so early in the season.

DE ONG (E. R.). **Insect, Fungus and Weed Control.**—8½ × 5 ins., 400 pp., 37 figs., many refs. New York, N.Y., Chemical Publ. Co., Inc., 1953. Price $10.

The review of recent information on pest control, which is noticed more fully elsewhere [*R.A.E.*, A **41** 154], includes sections, occupying 47 pages, on the control of insects and mites injurious or troublesome to man and livestock and of cattle ticks, particularly in the United States.

MERTIN (J. V.). **Pesticides : a Review of their Uses, Properties and Hazards.**—[2+] 123 pp., refs., multigraph. Adelaide, Dep. Hlth Aust., 1951. **Pesticides Quarterly Supplement no. 1, February 1952.**—pp. 124–138, 1 fig., 20 refs. **No. 2, May 1952.**—pp. 139–174, 1 graph, 70 refs. **No. 3, August 1952.**—pp. 175–223, 76 refs. **No. 4, November 1952.**—pp. 224–262, 81 refs.

This review collates information on the hazards to human health associated with materials used in pest control that was hitherto scattered throughout the industrial, agricultural, medical and other scientific literature, mainly that published in the British Commonwealth and the United States during 1945–51. It is based on nearly 800 papers and monographs. It comprises five chapters followed by a glossary of medical terms, the bibliography and an index. The first chapter deals with such subjects as general hazards and precautions, relative toxicities, and administrative measures for safeguarding health that have been adopted or recommended in various countries, and the second (pp. 19–84) with insecticides. These are classified primarily according to whether they were or were not in general use prior to 1939, and information is given on their chemical properties, uses in pest control and symptomatology in man, and on methods of treatment in cases of poisoning and precautionary measures. The remaining chapters contain similar data on fungicides and materials used to destroy weeds and rodents.

The supplements are the first four of a series that is to be issued quarterly to keep the information up to date. Their arrangement resembles that of the main review, and they are paged in sequence from it to facilitate the use of the yearly index that is to be provided.

BONNET (D. D.) & HU (S. M. K.). **The Introduction of *Toxorhynchites brevipalpis* Theobald into the Territory of Hawaii.**—*Proc. Hawaii. ent. Soc.* **14** no. 2 pp. 237–242, 2 figs., 4 refs. Honolulu, 1951.

Toxorhynchites brevipalpis Theo. was introduced into Hawaii from South Africa [*R.A.E.*, B **40** 4] because it was believed that its establishment would

help to control *Aëdes albopictus* (Skuse). The latter breeds in a great variety of natural and artificial containers [**39** 193], so that its control is very complicated, particularly in rural areas, where populations are built up that reinfest towns and discourage the use of many recreation areas. The first consignment of larvae of *T. brevipalpis* arrived in Honolulu by air in August 1950 and three more in October. The larvae were shipped between folds of moist filter paper in glass vials, each holding about 20. The time elapsing between despatch and receipt was 5–15 days, and 121 of the 196 larvae sent arrived alive. Mortality was not related to the duration of the transit period and was attributed to cannibalism.

The larvae were placed in individual containers of glass or bamboo, together with *Aëdes* or *Culex* larvae, and they fed without delay. They pupated 5–10 days after arrival, and the pupal stage occupied about 6·5 days. Emerging adults were released in a large insectary where the temperature ranged from 64 to 87°F. and the relative humidity was 70–80 per cent. They were provided with fruit and fresh flowers and balls of cotton-wool soaked in 10 per cent. maize syrup or honey. Various water containers were distributed about the room for oviposition. Both pairing and oviposition were observed and are described. Bamboo pots and wooden tubs appeared to be preferred sites for egg-laying, but eggs or larvae were also recovered from tin cans, glass jars and the axils of plants. Egg-laying was apparently inhibited by temperatures below 72°F. Eggs were placed in individual test tubes for hatching, the larvae were reared in individual glass tumblers to prevent cannibalism and were fed on *Culex* larvae of various sizes, and the pupae were removed to a cage so that the sex of the emerged adults could be determined. The egg and larval stages lasted about three days and four weeks, respectively. By the end of December 1950, 245 females and 252 males had emerged, and the percentages of eggs, larvae and pupae that had died had been about 33, 42·5 and 13. The mortality of the larvae is attributed largely to starvation, particularly during the early stages. During December 1950, 68 mated females and 35 males were released in a bamboo forest near Honolulu. The colony is being maintained and further releases will be made as numbers permit.

GALINDO (P.), CARPENTER (S. J.) & TRAPIDO (H.). **Ecological Observations on Forest Mosquitoes of an endemic Yellow Fever Area in Panama.**—*Amer. J. trop. Med.* **31** no. 1 pp. 98–137, 5 figs., 17 refs. Baltimore, Md., 1951.

In this third paper of a series [*cf. R.A.E.*, B **41** 25], ecological observations made during extensive field and laboratory studies of the breeding habits of the diurnal forest mosquitos of central Panama and the Canal Zone are recorded, together with additional observations on adult activities. Meteorological data are given, and the stations and methods of study are described. Larvae were collected weekly from tree holes and bamboo traps (short sections of bamboo) at four forest stations in the Republic and one at sea-level in the Canal Zone and from miscellaneous breeding containers (tin cans, fruit rinds and palm spathes) at three of the former and from tree holes and the miscellaneous containers in a mangrove swamp in the Republic and on an island in the Canal Zone [*cf. loc. cit.*]. Bamboo traps with open tops and others with closed tops and a small hole in the side were used. They were set at ground level and in the forest canopy. The tree holes were mainly at ground level. The number of larvae of each species obtained at each station in traps, holes and other containers, the annual cycle of abundance of larvae of each species obtained in bamboo traps, and the number of times the different species were found associated are shown in tables, and notes are given on the numerous species collected as larvae or adults.

Larvae of *Haemagogus spegazzinii falco* Kumm, Osorno-Mesa & Boshell were taken at only two stations and in extremely small numbers. It is thought probable that they occur mainly in tree cavities in the canopy, hardly any of which could be searched. Eggs laid in the laboratory had to be matured for at least two weeks under moist conditions in order to hatch. Few hatched after one flooding, but almost all did so after several well spaced dryings and floodings. Development from hatching to adult took 12–21 days. No males were taken in nature. Larvae of *H. equinus* Theo. were taken at all the forest stations. They occurred in tree holes and stump cavities in virgin forest and to some extent in cleared fields near the forest, but were abundant mainly in the bamboo traps, irrespective of height from the ground. Eggs hatched after either long or short periods of drying, and often after only one flooding. The time from flooding to adult emergence was 6–21 days, with an average of 9–10. Adult populations had often built up to a high level by May. The females fed primarily in the forest, but also in areas of second growth, in cleared fields and in mangrove swamps. Males were often seen. On the Pacific side of the Isthmus, *H. lucifer* (H., D. & K.), which was also taken at all forest stations, breeds in tree holes near the ground primarily in forest, but on the wetter Atlantic side it occurs in areas of second growth as well as in forest, and even in towns, where it breeds in holes in isolated trees and in artificial receptacles. The larvae were less commonly found in bamboo traps than those of *H. equinus* and very seldom occurred in traps much above ground level, whereas the females bit at all levels, with some preference for the canopy. The eggs hatched after either short or long periods of drying and after a varying number of floodings. Development from hatching to adult took about as long as in *H. s. falco*. Populations built up slowly. Males were seen but not so often as those of *H. equinus*. *H. argyromeris* Dyar & Ludl. appeared to be much more abundant on the island than did any of the other *Haemagogus* species in any of the other study areas. This species does not invade deep virgin forest, but small numbers were taken at most stations. Larvae were found in numbers only at low altitudes. They occurred in more varied breeding places than those of any other *Haemagogus* and were quite plentiful in the bamboo traps. The eggs were resistant to drought and hatched irregularly after several spaced floodings, and the population built up slowly after the onset of the rains. The females usually attack man only in the shade of second growth and at ground level. *H. chalcospilans* Dyar breeds predominantly in rot cavities in mangrove trees, but also in coconut hulls and other containers and, on occasion, ground pools. The larval stage may last 10–28 days. The females bit fiercely in the swamp, but were never observed biting outside it.

The undescribed species of *Aëdes* (*Finlaya*) closely related to *A. leucocelaenus* Dyar & Shann. [**41** 26] was only once taken in tree holes but bred in bamboo traps irrespective of vertical distribution at three forest stations in the Republic and the one in the Canal Zone. It appeared to be more or less restricted to the slopes of forested hills at altitudes of 150–2,300 ft. Eggs needed to be conditioned for at least two and usually three or four weeks before hatching, which occurred over a long period ; larvae developed rather evenly in about 10 days. Adults do not become numerous until June, a month or more after the heavy rains begin. Larvae were found from July to February. *A. leucotaeniatus* Komp was generally restricted to the slopes of forested hills at elevations above 1,000 ft. Eggs were laid in bamboo traps at all levels. Almost all eggs hatched at the first flooding after ripening for two weeks. The larval stage occupied about two weeks. Larvae were found from June to January.

The species of *Sabethes* taken included *S. cyaneus* (F.) and *S. chloropterus* (Humb.). Both occurred from sea-level to 2,100 ft. Larvae of *S. chloropterus* were not found in numbers commensurate with the adult catch, but those of *S. cyaneus* were abundant, largely because of the great attraction for it of the

bamboo traps irrespective of vertical distribution. The natural breeding places of both species are tree holes with a large cavity and a small opening, that can hold water all the year round, and adults are present throughout the year, though they are most abundant in July–September. Man is apparently a secondary host of *S. cyaneus*. The extent to which this species feeds on the forest monkeys and its ability to transmit yellow fever are suggested as subjects for careful study, as it and *S. chloropterus* seem to be the only diurnal mosquitos of the area able to carry over the three months of severe dry season, when no adults of species of *Haemagogus* or *Aëdes* (*Finlaya*) are found.

Brennan (J. M.). **The Occurrence of *Anopheles crucians* in Guatemala.**—*Amer. J. trop. Med.* **31** no. 1 p. 138, 1 ref. Baltimore, Md., 1951.

In Central America, *Anopheles crucians* Wied. was formerly known only on the Atlantic slope in British Honduras [*R.A.E.*, B **11** 43–44], Honduras and Nicaragua [**31** 169]. However, during an Anopheline survey of Guatemala, the typical variety was found breeding prolifically as the dominant Anopheline in association with *A. albimanus* Wied., *A. argyritarsis* R.-D. and *A. hectoris* Giaquinto Mira in a fairly large semi-permanent marsh in a narrow valley at an elevation of 3,500 ft. on the Pacific side. The vegetation was dense and high so that the underlying water was not readily seen. The three associated species disappeared as the dry season progressed from November 1949 to May 1950, but *A. crucians* continued to breed with no apparent reduction in its numbers, and this is thought to indicate that it has been established for some time.

Downs (W. G.), Celis S. (H.) & Gahan (J. B.). **Control of *Anopheles pseudopunctipennis* in Mexico with DDT residual Sprays applied in Buildings. Part III. Malariological Observations after five Years of annual Spraying.**—*Amer. J. Hyg.* **52** no. 3 pp. 348–352, 4 refs. Baltimore, Md., 1950.

The following is based on the authors' summary. Spraying of houses once annually in March or April in five successive years (1945–49) in one Mexican village and in the last four of these years in another to leave deposits of DDT for the control of *Anopheles pseudopunctipennis* Theo. [*R.A.E.*, B **40** 98, etc.] resulted in a marked reduction, estimated at between 75 and 90 per cent., in the incidence of malaria in both. The DDT was applied, first as an emulsified solution and in later years as a wettable-powder suspension, at an estimated rate of 200 mg. per sq. ft. Larvae and adults of *A. pseudopunctipennis*, though less abundant than before spraying was begun, remained common in the region, but adults were rarely seen in the sprayed houses. Cases of malaria, contracted during the spraying programme, have been seen in the resident population, but they have been few.

Mathis (W.), Ferguson (F. F.), Upholt (W. M.) & Quarterman (K. D.). **The relative Effectiveness of DDT and DDD as Anopheline Mosquito Larvicides under Field Conditions.**—*J. nat. Malar. Soc.* **9** no. 1 pp. 95–98, 3 refs. Columbia, S.C., 1950. (With a Summary in Spanish.)

The following is based on the authors' summary. In replicated tests under natural conditions in Georgia in 1946 and 1947, DDT and DDD showed no significant difference in effectiveness in the control of Anopheline larvae, when both were applied at 0·05 lb. per acre in 1 U.S. gal. No. 2 fuel oil with 0·5 per cent. spreading agent added. Results obtained with lower dosages were so erratic that valid comparisons were impossible. These experiments confirm previous findings that 0·05 lb. per acre is the minimum dosage at which DDT can be effectively applied by hand sprayers with present methods, materials and equipment. They also indicate that the same is true of DDD.

Lombardini (G.). **Osservazioni biologiche ed anatomiche sul** *Rhipicephalus sanguineus* **Latr. (Acarina, Ixodidae).** [Biological and anatomical Observations on *R. sanguineus.*]—*Redia* **35** pp. 173–183, 5 figs., 1 graph, 4 refs. Florence, 1950.

Five females of *Rhipicephalus sanguineus* (Latr.) taken in May 1946 laid 4,161–4,917 eggs each between 4th June and 4th July. The process of oviposition is described in detail. The eggs are covered with the liquid from the cephalic gland (Gené's organ), which protects them from desiccation but permits respiration, even under water, owing to its oxygen-absorbing properties. At 20–25°C. [68–77°F.], the eggs hatched in 38 days in air and in 51 days in distilled or spring water. Some of the eggs in spring water were attacked by a fungus of the genus *Fusarium*, which killed the embryos. The larvae survived for 30–35 days in spring water, whereas others kept without food in a moist atmosphere in petri dishes were all dead after 12 days.

de Pietri-Tonelli (P.). **Contributo alla conoscenza della resistenza al DDT della** *Musca domestica* **L.** [A Contribution to Knowledge of the Resistance of *M. domestica* to DDT.]—*Redia* **35** pp. 407–440, 2 pls., 8 figs., refs. Florence, 1950.

The literature on the acquired resistance of various insects to insecticides is reviewed, with special reference to *Musca domestica* L. and DDT, and an account is given of studies begun in Italy in 1948 in which a strain of *M. domestica* resistant to DDT was reared from 700 individuals showing incipient resistance to it. The rearing was carried out at an average temperature of 27°C. [80·6°F.] and relative humidity of 70 per cent., and the breeding medium consisted of 25 per cent. bran, 12·5 per cent. lucerne meal, 0·9 per cent. malt, 0·6 per cent. brewers' yeast and 61 per cent. water. Adults of each generation were exposed for three hours to a deposit of DDT in a glass vessel at 1 gm. per sq. m., within a day of emergence, before pairing took place, and mortality was recorded 24 hours later. The survivors were placed in cages containing milk for food, and cotton-wool soaked in milk for oviposition, and the eggs were transferred to the breeding medium. The complete life-cycle lasted 16–17 days, and rearing was continued for 31 generations. The percentages of the flies killed by the DDT fell irregularly from 79 in the first generation to 25–30 in the 13th–16th and to less than 5 in the 28th–31st, and were 4·8, 2·6 and 4 in a final test in which flies of the last generation were exposed for 24 hours to 1, 2 and 4 gm. DDT per sq. m., respectively.

Concurrently, a test was made to find whether the DDT-resistant strain would retain its resistance without contact with the insecticide. Eggs taken from adults of the 14th generation that had not been exposed to DDT were reared and some of the resulting adults were exposed to DDT in the usual way while the others were used for rearing. A further 16 generations were reared and tested in this manner. The percentage mortality given by DDT fluctuated considerably in the successive generations, but rose to about 80 in the last two.

The effects of DDT on larvae of the resistant and a susceptible strain were compared by mixing it with the breeding medium at 0·06, 0·12, 0·3 and 0·6 per cent. by weight. The percentage mortality was proportionate to the concentration of DDT, and in one test of which the results are shown, the numbers of puparia and (in brackets) normal adults obtained from 1,500 eggs were 108 (23), 12 (7), 0 (0) and 0 (0), respectively, for the susceptible strain and 1,476 (982), 807 (243), 355 (0) and 8 (0) for the resistant one. Many of the adults of both strains died while emerging

(1319) Wt. P9/3884 7/53 E.P. Ltd. Gp. 566 [B]

from the puparia and some of those of the resistant strain that emerged showed deformities of the wings. It is concluded that there is a limited resistance to DDT in the immature stages of a strain that is resistant in the adult stage.

To test their susceptibility to other insecticides, flies of the resistant and susceptible strains were exposed for one hour to deposits on glass, mortality was recorded after 24 hours, and log-probit dosage-mortality curves were plotted. The results showed that the deposits required to kill 50 per cent. of the resistant and (in brackets) susceptible strains, expressed in mg. per sq.m., were 0·052 (0·023) for γ BHC, 0·25 (0·198) for chlordane, 0·03 (0·023) for heptachlor, 0·041 (0·024) for aldrin, 0·061 (0·049) for dieldrin, 17·47 (11·88) for toxaphene and 0·09 (0·12) for parathion. The median lethal deposits of p,p′DDT, p,p′methoxy-DDT and p,p′fluoro-DDT were 1·02, 1·7 and 1·2 mg. per sq.m. for the susceptible strain, whereas much heavier deposits of these three insecticides gave no appreciable mortality of the resistant one.

The percentages of flies of the resistant and susceptible strains knocked down by an atomised spray of 2 per cent. Thanite (isobornyl thiocyanoacetate) in kerosene were about 70 and 90, respectively, and the periods required for recovery of all flies knocked down were about two and four hours; and these differences in the knockdown activity of Thanite were also evident in tests in which caged flies of both strains were exposed in a room to aerosols produced from solutions containing 2 per cent. Thanite with 3 per cent. DDT or 1·5 per cent. chlordane, released at the rate of 1 gm. per 13·2 cu. ft. With the DDT-Thanite mixture all flies of the susceptible strain were knocked down in 15 minutes and remained inactive until they died, whereas only 60 per cent. of the flies of the resistant strain were knocked down and these recovered completely in a short time. The chlordane-Thanite caused 95 per cent. knockdown of the susceptible flies in 15 minutes and complete mortality in a few hours, though 5 per cent. of the flies became active for an hour or so after knockdown. There was again 60 per cent. knockdown of the resistant strain followed by resumption of activity, but mortality was virtually complete a few hours later, though it did not begin so quickly as in the susceptible strain.

[Grunin (K. Ya.).] Грунин (К. Я.). **Contribution to the Question of the Transition of Botflies to new Hosts.** [*In Russian.*]—*Ent. Obozr.* **31** no. 1–2 pp. 85–89, 3 figs., 17 refs. Moscow, 1950.

This paper includes a record of the finding in March 1947 of two third-instar larvae of *Hypoderma lineatum* (Vill.) in a yak (*Poephagus grunniens*) in the region of Murghab in the Pamirs.

[Sukhova (M. N.).] Сухова (М. Н.). **New Data on the Ecology and epidemiological Importance of the blue Meat Flies** *Calliphora uralensis* **Vill. and** *Calliphora erythrocephala* **Meig. (Diptera, Calliphoridae).** [*In Russian.*]—*Ent. Obozr.* **31** no. 1–2 pp. 90–94, 2 figs., 3 refs. Moscow, 1950.

Notes based partly on observations in the laboratory and in the field near Moscow in 1948–49 are given on the bionomics of *Calliphora uralensis* Villen. and *C. erythrocephala* (Mg.) together with characters differentiating these two species, which have been confused in the Soviet Union owing to the lack of any description of the specific characters of the former in Russian. *C. uralensis* is much commoner than *C. erythrocephala* in the central zone of the Union, the two species constituting 95 and 5 per cent., respectively, of all the *Calliphora* adults collected in summer. *C. erythrocephala* passes

the winter in the adult stage without diapause and can reproduce under favourable conditions throughout the winter. In spring, the first adults were observed in the field about the middle of April. The larvae sometimes occurred in compact human faeces, but were commonest in decaying meat and in the carcasses of small animals. Of the flies reared from larvae collected from meat refuse in a slaughter-house, 75 per cent. were *C. erythrocephala* and 25 per cent. *C. uralensis*.

C. uralensis developed in liquid human faeces in covered or open latrine pits. The eggs were laid on the soiled wooden parts of the pits and on the surrounding sodden ground, and the larvae made their way into the pits. They were not found in manure, animal droppings, compact human faeces or household refuse. The adults fed on faeces, 40 per cent. of the males and females dissected containing fresh faecal material, and congregated in large numbers on shrubs and grass close to public latrines. Hibernation occurred in the prepupal or pupal stage. The adults first appeared in the field in the middle of May, were numerous until the end of September and disappeared in October, after the onset of frosty weather. In the laboratory, at 18–25°C. [64·4–77°F.], the egg stage lasted 14–20 hours, and the larval and pupal stages 10–14 and 7–10 days, respectively. The adults lived for up to 110 days.

Both species were attracted to sweet and fermenting materials and to vegetables and fruit in markets and were common in houses. Experiments showed that *C. uralensis* could deposit viable dysentery bacilli of a laboratory strain for two days after being infected, and a similar but serologically different strain was isolated from 35 flies of the same species caught at a place where dysentery was prevalent. Of adults taken on food products or in food stores, 6–13 per cent. had eggs of parasitic worms in the digestive tract or on the body surface.

C. uralensis is the more important of the two species epidemiologically. The measures recommended against it are mainly designed to improve sanitation and prevent access to faeces, but include the use of DDT sprays on walls, etc., against the adults.

[Skruinnik (A. N.).] Скрынник (А. Н.). **The blood-sucking Arthropods of southern Sakhalin.** [*In Russian.*]—*Ent. Obozr.* **31** no. 1–2 pp. 109–112, 2 figs., 6 refs. Moscow, 1950.

During investigations in southern Sakhalin in July–August 1947, three species of *Ixodes* were obtained by dragging flags over grass and shrubs and examining domestic and a few wild animals, and 24 species of blood-sucking Diptera by collecting flying insects that settled on a person sitting motionless for periods of 20–27 minutes. The animals examined were practically free from ticks, but local inhabitants stated that man and domestic animals were attacked in spring and that ticks were abundant in late April and early May. The Diptera comprised ten species of mosquitos, ten of Tabanids, three of *Culicoides* and one of *Simulium*. No Anophelines were taken, and malaria is unknown in Sakhalin. A list of the 27 species is given, showing the localities in which each occurred.

[Zhmaeva (Z. M.).] Жмаева (З. М.). **Parthenogenetic Development of *Haemaphysalis bispinosa* Neum. (Acarina, Ixodidae).** [*In Russian.*] —*Ent. Obozr.* **31** no. 1–2 pp. 121–122, 3 refs. Moscow, 1950.

Records of parthenogenetic reproduction in Ixodid ticks are cited [*cf. R.A.E.*, B **41** 67], and a brief account is given of laboratory investigations of its occurrence in *Haemaphysalis bispinosa* Neum. Engorged females

were taken from cows in the Maritime Province in 1947, and the larvae and nymphs obtained from eggs laid by them fed on a rabbit in February and April 1948. The resulting adults, all of which were females, refused to feed on a guineapig in October, but did so in April 1949 and laid viable eggs. Their feeding was very protracted and some remained on the host for 13 days. Embryonic development was also slow, the eggs not hatching for six weeks. The females were subsequently allowed to feed on a rabbit or guineapig in July 1949 and engorged in 5–7 days (with the exception of two that did not engorge completely). Oviposition occurred 6–7 days later. Eggs laid by the females that had fed on the rabbit required more than a month to hatch. Those laid by females that had fed on the guineapig began to hatch in 6–7 days. The larvae fed on a guineapig for 3–4 days and moulted 10–14 days after dropping from the host. The nymphs engorged in four days, dropped after three days and moulted 17–20 days later. All the adults were females. Throughout the experiments, fecundity and viability were normal.

[Vinogradskaya (O. N.).] Виноградская (О. Н.). **The Spiracles of *Anopheles* and their Variations depending on the Xerophily and Hygrophily of the individual Species.** [*In Russian.*]—*Ent. Obozr.* **31** no. 1–2 pp. 151–154, 2 figs., 4 refs. Moscow, 1950.

To supplement a previous paper [*R.A.E.*, B **37** 27], figures are given of the abdominal spiracles of *Anopheles superpictus* Grassi, *A. pulcherrimus* Theo., *A. maculipennis* Mg. vars. *sacharovi* Favr and *messeae* Flni., *A. lindesayi* Giles, *A. hyrcanus* (Pall.), *A. marteri* Sen. & Prun. var. *sogdianus* Keshish'yan, *A. algeriensis* Theo., *A. claviger* (Mg.) (*bifurcatus*, auct.), *A. plumbeus* Steph., *Aëdes caspius* (Pall.) and *A. cinereus* Mg., and the pro- and metathoracic spiracles of *Anopheles maculipennis* var. *messeae* are described. It is concluded that the simple and apparently ineffective way in which the thoracic spiracles of *A. maculipennis* close is one cause of the ready loss of water that is characteristic of this and some other species of *Anopheles*. The abdominal spiracles of *Anopheles* possess a more perfect closing apparatus with a well-developed valve. In the hygrophilous species of *Anopheles* and *Aëdes* [*cf.* **34** 179–180; **37** 27] the openings of the abdominal spiracles are relatively larger and the post-spiracular chamber is cylindrical, whereas in the xerophilous species the openings are smaller and the post-spiracular chamber is conical. The size and shape of the abdominal spiracles and the relative size [*cf.* **31** 188] of the thoracic spiracles are adaptations to existence under different climatic or micro-climatic conditions.

Ryckman (R. E.). **Laboratory Culture of Triatominae with Observations on Behavior and a new Feeding Device.**—*J. Parasit.* **38** no. 3 pp. 210–214, 1 fig. Lancaster, Pa., 1952.

Several years' experience in the rearing of Triatomine bugs at Berkeley, California, showed that a temperature of 29–30°C. [84·2–86°F.] and a relative humidity of 50–60 per cent. provided optimum conditions for health and reproduction, though *Triatoma infestans* (Klug) was reared successfully at relative humidities varying from 32 to 96 per cent. Colonies were kept in vials or in jars covered with nylon cloth with 40 threads to the inch. Wide-mouthed jars had screw-cap rims covered with nylon cloth held in place by a rubber band and secured with adhesive tape. They could thus be easily opened and securely closed to prevent the escape of the bugs. Four thicknesses of pleated paper towelling placed upright in the jars

afforded resting and hiding places for the bugs and enabled them to reach the host to feed. For constant reproduction, *Triatoma* should be fed at least every ten days.

The qualities needed in a feeding and rearing unit are cited, and a feeding device that has been in use for two years is illustrated. It enables a rabbit to be held in a natural and comfortable position, with the abdomen, from which the hair has been clipped, in contact with the nylon cover of a jar of bugs. The bugs feed through the nylon and, as they have to feed from below, the rabbit cannot be contaminated with their faeces and risk of their infecting it with *Trypanosoma cruzi* is prevented.

Triatomines cannot take wing successfully from shallow enamel pans, and those of genera other than *Rhodnius* are adequately confined in such pans by perpendicular sides 2 ins. high. Adults and nymphs of *R. prolixus* Stål, however, can readily climb vertical glass or enamel surfaces. A two-inch band of medical adhesive tape with the gummed side exposed is an effective barrier to crawling *Triatoma* and could be used to ring the legs of a bed.

Holdenried (R.). **Sylvatic Plague Studies. VIII. Notes on the Alimentary and Reproductive Tracts of Fleas, made during experimental Studies of Plague.**—*J. Parasit.* **38** no. 4 Sect. 1 pp. 289–292, 5 refs. Lancaster, Pa., 1952.

The observations recorded were made in the course of studies of sylvatic plague [*cf. R.A.E.*, B **41** 64] by microscopical examination of living examples of *Diamanus montanus* (Baker), *Polygenis gwyni* (Fox) and *Xenopsylla cheopis* (Roths.). It was found that clear globules formed after feeding in the ventriculi of *D. montanus* and *X. cheopis* but not of *P. gwyni*. Bubbles present in some starved adults of both sexes of *P. gwyni* were rapidly eliminated after feeding. The bubbles were never seen in *D. montanus* or *X. cheopis*. Persistence of dark particles in the ventriculus after ingestion of a fresh meal of blood containing plague bacilli indicated that the flea had become infected. Visible remains of previous blood meals in normal fleas (*D. montanus*) sometimes disappeared within 24 hours, but occasionally persisted for as long as 10 days. If the alimentary canal of the flea was blocked by plague bacilli, the action of the pharyngeal pump continued after removal from the host in individuals of *P. gwyni* and was most persistent and vigorous on the day or days immediately preceding death. This persistent action was occasionally noted in other species, but was never so vigorous as in *P. gwyni*, a particularly robust species. Plague-infected fleas, particularly those with a blocked digestive tract, usually shrank. The abdomen sometimes telescoped anteriorly, forcing the proventriculus into the pronotum and displacing the oesophagus. Shrunken fleas always died, usually within a day or two. The quantity of faeces expelled and the rate at which they were eliminated did not seem to affect the rate at which fleas became free of plague organisms. Plague-infected females could produce eggs.

Wirth (W. W.). **Two new Species of anthropophilic *Culicoides* from Guatemala (Diptera: Heleidae).**—*J. Parasit.* **38** no. 3 pp. 245–247, 1 fig. 2 refs. Lancaster, Pa., 1952.

Gibson (C. L.) & Ascoli (W. F.). **The Relation of *Culicoides* (Diptera: Heleidae) to the Transmission of *Onchocerca volvulus*.**—*T.c.* no. 4 Sect. 1 pp. 315–320, 1 graph, 18 refs.

The first paper contains descriptions of *Culicoides stigmalis*, sp. n., from Guatemala and Panama and *C. gibsoni*, sp. n., from Guatemala. All the

Guatemalan examples were collected in the same district, and some during the studies described in the second paper.

In the latter, the literature on the transmission of filariae by Ceratopogonids is reviewed [*R.A.E.*, B **16** 155; **22** 251; **25** 57; **28** 105, 106; **30** 167, etc.], and an account is given of investigations made throughout 1951 on a plantation in the Department of Chimaltenango, where *Onchocerca volvulus* is endemic in man. Microfilariae were found in the skin of 14 per cent. of the inhabitants of the plantation. Four species of *Culicoides*, *C. paraensis* (Goeldi), *C. stigmalis*, *C. gibsoni* and *C. guttatus* (Coq.), were taken alighting on uninfected human volunteers. No evidence of natural infection was found on dissection in any of the 929 individuals taken on the volunteers, but the numbers of *C. gibsoni* and *C. guttatus* were too small for significance. *C. paraensis* was always the dominant and most annoying species and bit at any hour and in any weather. A dimethylphthalate repellent prevented biting on treated skin but did not discourage biting on any untreated area, however small. *C. gibsoni* bit under the same conditions. *C. stigmalis* bit most frequently between 4.30 and 6 p.m. with the sky partly overcast. It was never numerous. *C. guttatus* bit only during or immediately after light rain.

In studies of experimental infection, about 560 adults of *C. paraensis*, 305 of *C. stigmalis*, 47 of *C. guttatus* and about 17 of *C. gibsoni* were fed on a human volunteer heavily infected with *O. volvulus* and were dissected when they died. Microfilariae were not found in any example of *C. paraensis* or *C. gibsoni*, but were found in 58 examples of *C. stigmalis* and one of *C. guttatus*. In no case, however, had the ingested microfilariae undergone perceptible development, and the midges that had ingested them died much more rapidly than examples of the same species that had not. It is concluded that *C. stigmalis* is not a suitable intermediate host for *O. volvulus* and that *C. paraensis* cannot ingest the microfilariae. The tests with *C. guttatus* and *C. gibsoni* were not extensive enough to prove that they cannot transmit *Onchocerca*, but their rarity made it most unlikely that they were actually involved. It is of interest, however, that *C. filariferus* Hoffman, in which Dampf found developmental forms of filarial larvae, possibly including *O. volvulus* (*caecutiens*), in Mexico [**25** 57; **28** 106], is considered by Macfie [and Lane] to be identical with *C. guttatus* [**39** 93; **41** 32].

Fischer (R. G.) & Syverton (J. T.). **The Cockroach as an experimental Vector of Coxsackie Virus.**—*Amer. J. trop. Med.* **31** no. 2 pp. 238–242, 17 refs. Baltimore, Md., 1951.

A brief review of the literature shows that viruses of the Coxsackie group, the discovery of which was recorded in 1948, are responsible for human disease diagnosed clinically as non-paralytic poliomyelitis, "summer grippe", aseptic meningitis, epidemic myalgia, pleurodynia and, probably, Bornholm disease. They are probably transmitted by faecal-oral dissemination, as they have been isolated from faeces and throat washings of patients and also from sewage and flies. If flies carry the virus from human faeces to food, cockroaches are even more likely to do so under some conditions, as they live longer, and are gregarious and active by night, and an investigation was therefore undertaken to determine whether *Periplaneta americana* (L.) could acquire, maintain and excrete a virus of the group. A Minnesota strain was used. The cockroaches were strapped by adhesive tape to corks, and each was given a single feed of 0·2 ml. of a 10 per cent. suspension made up from the hind limbs of mice moribund of Coxsackie infection. They were subsequently fed only on normal food and water, and faecal specimens were collected daily and tested by injection of 0·05 ml.

of the supernatant fluid from an antibiotic-treated 1 per cent. suspension into suckling mice 24–48 hours old. The results showed that enough virus to kill the mice was excreted daily by the cockroaches over periods of 7–15 days, and the hind limbs in 1 per cent. suspension from the dead recipient mice contained virus in lethal dosage on passage to litters of normal mice.

Smith (C. N.). **Compounds more toxic to Fleas than DDT.**—*Amer. J. trop. Med.* **31** no. 2 pp. 252–256, 2 refs. Baltimore, Md., 1951.

Laboratory tests were carried out with 620 insecticides to evaluate their effectiveness in dusts against *Ctenocephalides felis* (Bch.) and *Xenopsylla cheopis* (Roths.), and the results obtained with 50 of the more effective ones are given in a table. The dusts were evenly applied at 4 gm. per sq. ft. to the surface of a layer of loose earth in jars, and 20 fleas were exposed in each jar for 24 hours. The dusts contained 0·5, 0·05 and 0·005 per cent. toxicant, concentrations at which recrystallised DDT, the standard of comparison, killed 86, 51 and 17 per cent. of *C. felis* and 91, 55 and 12 per cent. of *X. cheopis*. At a concentration of 0·5 per cent., 29 compounds were more effective than DDT against *C. felis*, 24 were within the range of effectiveness of DDT, and 566 were less effective. The outstanding toxicants, with the percentages of *C. felis* killed by the 0·5 and 0·05 per cent. dusts in brackets, were BHC containing 95 per cent. γ isomer (99·5 and 99), heptachlor (99 and 99), dieldrin (99 and 100) and aldrin (95 and 97). These were virtually as effective against *X. cheopis* at both concentrations. Chlordane and parathion, which gave 97 and 98 per cent. kill of *C. felis* at 0·5 per cent., were also more effective than DDT at both 0·5 and 0·05 per cent., but toxaphene and pyrethrum extract with piperonyl butoxide were among those that were more effective at 0·5 per cent. only. Analogues of DDT were about equal to DDT itself.

Most of the compounds were less toxic to *X. cheopis* than to *C. felis*, but BHC and pyrethrum extract with piperonyl butoxide were more toxic to *X. cheopis*. Dusts of 13 of the better toxicants showed no evidence of deterioration after storage for 10–12 months in brown glass bottles at room temperature.

Sabrosky (C. W.). **Nomenclature of the Eye Gnats** (*Hippelates* **spp.**).—*Amer. J. trop. Med.* **31** no. 2 pp. 257–258, 16 refs. Baltimore, Md., 1951.

The author draws attention to his revision of the nomenclature and distribution of certain species of *Hippelates*, notably *H. flavipes* (Lw.) [*R.A.E.*, B **29** 144], because it has escaped the attention of several subsequent writers on this genus in connection with the epidemiology of yaws and various eye diseases. He also refers to the finding of a large proportion of *H. bishoppi* Sabrosky in a collection of some 40,000 individuals otherwise consisting of *H. pusio* Lw. from Florida [**41** 40], and states that the common form in the Coachella Valley in California, which is associated with severe outbreaks of epidemic conjunctivitis and has been recorded as *H. pusio* [**17** 54, etc.], is specifically or at least subspecifically distinct and should be known as *H. collusor* (Tns.).

Burgess (R. W.). **The Life History and Breeding Habits of the Eye Gnat, *Hippelates pusio* Loew, in the Coachella Valley, Riverside County, California.**—*Amer. J. Hyg.* **53** no. 2 pp. 164–177, 12 refs. Baltimore, Md., 1951.

An account is given of studies, carried out mainly in 1931–33, on the life history and breeding habits of *Hippelates pusio* Lw. in the Coachella

Valley of California, where it had been very troublesome during the preceding decade [*cf. R.A.E.*, B **18** 251, etc.]. The adults were abundant for about nine months annually and were thought to be responsible for a coincident, almost continuous, epidemic of follicular conjunctivitis. The methods used are described; they included direct observation, bait trapping, placing cages on the soil to catch adults emerging from it, and rearing.

The following is based on the author's summary. The population was found to fluctuate with the seasons, increasing in spring and autumn and decreasing in summer and winter [*cf.* **21** 38]. In experimental plots, 75·7 per cent. of the adults emerging during the whole year were from eggs laid during October and November. The winter was generally passed in the immature stages, but a few adults probably survive in favourable ecological niches. The sex ratio was about 1:1. The life-cycle occupied about 28 days under uncontrolled laboratory conditions (probably at temperatures of 75–90°F.), but it can be greatly prolonged in nature. Breeding is promoted by light, sandy soils, freshly ploughed-under organic matter, moisture and aeration [*cf.* **21** 38; **22** 129; **30** 59]. Little oviposition occurs in soil that has not been very recently cultivated.

Bordas (E.) & Downs (W. G.). **Control of *Anopheles pseudopunctipennis* in Mexico with DDT residual Sprays applied in Buildings. Part IV. Activity Pattern of Adult *A. pseudopunctipennis* Theo.**—*Amer. J. Hyg.* **53** no. 2 pp. 217–223, 3 figs., 18 refs. Baltimore, Md., 1951.

As part of an experiment on the control of malaria in the state of Morelos, Mexico, by spraying houses once a year with DDT to leave toxic deposits against *Anopheles pseudopunctipennis* Theo. [*R.A.E.*, B **41** 80, etc.], a study was made of the behaviour of the Anopheline in one of the treated villages. Though spraying had been carried out for five years, the adults were still numerous in occasional untreated houses on the periphery of the village. Specially built houses of the local pattern of rural construction were used. Outgoing mosquitos were caught in wooden-frame wire-gauze exit traps, and incoming ones were collected from the inner end of L-shaped entrance tunnels painted black on the inside with one open end fitted into the window and the other opening towards the ceiling.

It was found that the mosquitos enter houses for shelter rather than for feeding. Adults of both sexes (including females in all stages of nutrition and ovarian development) enter in numbers at dawn, and males, unfed females and females with fully developed ovaries leave at dusk. The mosquitos rest in the houses throughout the day, and engorged females tend to remain for several days, until their blood-meal is digested. Females were often observed feeding freely out of doors on man and domestic animals. Few entered houses to feed on human bait. The shelter-seeking habits of *A. pseudopunctipennis* explain the success of house-treatment with DDT in controlling malaria in areas of Mexico where it is the main vector.

Bradley (G. H.) & Lyman (F. E.). **Discussion of Five Years' Use of DDT Residuals against *Anopheles quadrimaculatus*.**—*J. nat. Malar. Soc.* **9** no. 2 pp. 113–118, 3 refs. Columbia, S. C., 1950. (With a Summary in Spanish.)

A summary is given of the results of operations carried out in five seasons (1945–49) in the south-eastern United States using deposits of DDT on the

interiors of houses and privies for the control of *Anopheles quadrimaculatus* Say. Two applications of DDT at 100 mg. per sq. ft. were made in 1945, but in subsequent years one application of 200 mg. was made in nearly all States. The percentages of sprayed houses inspected in 13 States that were found free of *A. quadrimaculatus* in the five years with the corresponding percentages for unsprayed houses in brackets were 97·2, 99 (87·3), 98·8 (72), 97·2 (83·3) and 98·9 (91·2). No unsprayed houses were examined in 1945, but the figures for the next four years indicated control percentages of 92·1, 95·7, 83·2 and 87·5, respectively. The comparatively low control in 1948 is attributed to the use of sub-standard formulations of DDT in some areas in that year. The sprayed houses were inspected over a period of five months in each season, and the average percentage free from infestation fell from 99 in the first month after treatment to 96·7 in the fifth. Most of the reduction was in the last month. A statistical treatment of the data shows that significant differences occurred from year to year between the relative number of sprayed and unsprayed houses in which *A. quadrimaculatus* was found and supports the conclusion that real differences occurred in the control percentages as calculated for each of the years.

Hunninen (A. V.), Young (M. D.) & Burgess (R. W.). **The Infection of Anopheline Mosquitoes by native Avian Malaria.**—*J. nat. Malar. Soc.* **9** no. 2 pp. 145–150, 9 refs. Columbia, S. C., 1950. (With a Summary in Spanish.)

Experiments with *Plasmodium lophurae* [*cf. R.A.E.*, B **31** 186; **33** 139, etc.] and *P. gallinaceum* have shown that both can develop in *Anopheles quadrimaculatus* Say, but as the birds on which the mosquito was fed were not natural hosts of the parasites and may conceivably have altered their characters, it remained to be proved that Anophelines can be infected with the agents of avian malarias in nature. In studies in South Carolina, *A. quadrimaculatus* and *A. crucians* Wied., as well as *Culex pipiens pipiens* L. (the control) acquired infection with *Plasmodium praecox* (*relictum*) by feeding on infected wild-caught English sparrows (*Passer domesticus*). *P. praecox* had been found to be the most prevalent species of *Plasmodium* in local birds. Development to the sporozoite stage occurred in 6·7 per cent. of *A. quadrimaculatus* dissected and 31·5 per cent. of *C. p. pipiens* but not in *A. crucians*. *A. quadrimaculatus* showed a higher rate of infections of the gut (43·3 per cent.) than did *C. pipiens* (23·2 per cent.). There were slight differences in the times of dissection of the two species. The finding that Anopheline mosquitos can be readily infected by malaria in native birds is of considerable importance in interpreting data on the incidence of human malaria based on mosquito dissection. When fed on canaries in which infections had been induced, 7·8 and 12·9 per cent. of *C. p. pipiens* and 1·9 and 0 per cent. of *A. quadrimaculatus* were found with gut and gland infections, respectively. *A. crucians* failed to become infected.

Sasse (B. E.) & Hackett (L. W.). **Note on the Host Preferences of** *Anopheles pseudopunctipennis*.—*J. nat. Malar. Soc.* **9** no. 2 pp. 181–182. Columbia, S. C., 1950. (With a Summary in Spanish.)

A stable trap baited in rotation with a man, a goat, a pig, a calf and a donkey was operated five nights a week for 12 weeks from April 1948 in a malarious village of coastal Peru. The average nightly catches of *Anopheles*

pseudopunctipennis Theo. with the five baits were 33·8, 42, 42·6, 45·5 and 62·3, respectively. Throughout the study, the trap was near a large number of dwellings, which the mosquitos could enter and leave easily, and it was evident that the latter preferred the common domestic animals to man.

A. pseudopunctipennis is the principal malaria vector in the Andean region of South America from Ecuador to northern Chile, but does not appear to be a very efficient one in coastal Peru [*R.A.E.*, B **39** 115]. It is probable that it is represented by geographical varieties [*cf.* **39** 73] and that these varieties may prove to differ in their host preferences and importance as vectors of malaria.

Burgess (R. W.) & Young (M. D.). **The comparative Susceptibility of** *Anopheles quadrimaculatus* **and** *Anopheles freeborni* **to Infection by** *Plasmodium vivax* **(St. Elizabeth Strain).**—*J. nat. Malar. Soc.* **9** no. 3 pp. 218–221, 3 refs. Columbia, S. C., 1950. (With a Summary in Spanish.)

In a series of 40 simultaneous comparative feedings involving 3,238 mosquitos, *Anopheles maculipennis freeborni* Aitken, the accepted malaria vector in the far west of the United States [*cf. R.A.E.*, B **36** 194, etc.] showed greater susceptibility than *A. quadrimaculatus* Say, the south-eastern vector, to infection by a domestic strain (St. Elizabeth) of *Plasmodium vivax*. Not only was there a higher percentage of mosquitos infected (65·53 as compared with 58·87), but the mean number of oöcysts and average sporozoite intensity per infected mosquito were both greater in *A. m. freeborni*. A similar difference in susceptibility between the two species had previously been shown to exist with regard to an imported strain of *P. vivax*.

Micks (D. W.). **The lethal Effect of the Ciliate,** *Vorticella microstoma* **Ehrenberg on** *Anopheles quadrimaculatus* **Larvae.**—*J. nat. Malar. Soc.* **9** no. 3 pp. 256–258, 1 fig., 2 refs. Columbia, S. C., 1950.

In June 1950, the larvae in a colony of *Anopheles quadrimaculatus* Say that had been established early in the year from eggs received from Alabama and had been maintained for some months with no difficulty began to behave in a sluggish, atypical manner and died off until none of the original 7,000 remained alive, although those that appeared to be healthy were transferred to new pans with clean water. A few survived to the pupal stage, but died soon after moulting. There was no mortality in the first or second instars. Examination of living and dead larvae showed that they were covered with a thick growth of *Vorticella microstoma* with interspersed débris. Colonies of *Culex pipiens fatigans* Wied. (*C. quinquefasciatus*, auct.) and *Aëdes aegypti* (L.) were reared, like the Anopheline colony, in distilled water and received the same food, but although the pipette used to pick up pupae of all three was also used in removing dead larvae of *A. quadrimaculatus* before the ciliates were discovered, examination of *Culex* and *Aëdes* larvae failed to reveal any attached *Vorticella*. Moreover, there was no mortality in any instar among larvae of these two mosquitos in an experiment in which heavily infected Anopheline larvae, mostly dead, were placed in pans with them.

Rehn (J. W. H.), Henderson (J. M.) & Serrano (J. M.). **Field Studies on the Bionomics of** *Anopheles albimanus*. **Part I: Aestivation of Immature Stages—Progress Report.**—*J. nat. Malar. Soc.* **9** no. 2 pp. 176–180, 2 figs., 3 refs. Columbia, S. C., 1950. (With a Summary in Spanish.)

Rehn (J. W. H.), Maldonado Capriles (J.) & Henderson (J. M.). **Parts II and III: Diurnal Resting Places—Progress Report.**—*T. c.* no. 3 pp. 268–279, 3 refs. (With a Summary in Spanish.)

The work described in these three reports was carried out in Porto Rico in 1948–49 and was designed chiefly to elucidate aspects of the bionomics of *Anopheles albimanus* Wied. of actual or potential significance in its control or eradication or in the control of malaria, of which it is believed to be the chief local vector.

The adults become numerous very soon after the beginning of the rains, particularly along the south coast, where the dry season is more sharply defined than in other parts of the island, and the possibility that the immature stages might aestivate was the subject of the investigation described in the first report. Observations were made at irregular intervals between November 1948 and April 1949 in localities of different types on the south coast, and larvae were found to be numerous in all of them during the earlier months. They began to dry in late December. By early April, nearly all were dry, and 356 soil samples were collected from the dried areas, wetted and kept in the laboratory for observation. However, no Anophelines were seen, though *Psorophora* larvae, Psychodids and Chironomids were often found, and it would seem that the immature stages of *A. albimanus* did not aestivate under the conditions of the investigation.

The second and third reports consist of accounts of attempts to find the diurnal resting places of *A. albimanus* in the 1949 season. The second, by Rehn and Henderson, describes sporadic inspections made between January and May in conjunction with the visits to breeding places described in the first report and more extensive investigations made on the north coast from June to December. Both were substantially unproductive. In the south, adults were found resting in small to moderate numbers in one area only. Some were scattered from ground level to a height of at least 20 ft. on the vertical surface of a limestone cliff, within a quarter of a mile of a breeding place surrounded by pasture in which cattle remained overnight. These mosquitos were protected from wind and from direct sunlight, but were in otherwise fairly exposed positions with a relative humidity of 85–90 per cent., never in crevices or other protected, dark and more humid situations; males were more numerous than females. Moderate numbers were found on the undersides of small limestone rocks near the water's edge, along a fence and scattered on the ground. Caves were unproductive. On the north coast, chief attention was given to areas surrounding relatively well-isolated sources of blood-meals near places where breeding was heavy. Keg shelters [*R.A.E.*, B **31** 52] in a variety of situations and positions, sweeping and beating of vegetation of many kinds, and extensive direct searching in varied situations failed to yield Anophelines, and enclosing areas of pasture, etc., in bednets and spraying with an irritant solution yielded only a few, though 30–70 per cent. of mosquitos released under bednets where all predators except lizards had access to them were found living after 24 hours and *A. albimanus* was abundant in the study area.

The work described in the third report was carried out in the west by Maldonado Capriles in the latter part of the year and was also inconclusive. Potential resting places of various ecological types were searched visually

or by sweeping but yielded only small numbers of *A. albimanus* and *A. grabhami* Theo. of both sexes on a few occasions. These were principally in low vegetation under coconut palms or *Citrus*. Three females of *A. albimanus* and three males and 54 females of *A. grabhami* were seen under one house, and Anophelines were swept from grass around the house. It is believed that shelter from wind rather than humidity was the controlling factor in determining resting places. A large number of *A. albimanus* may have been resting on the large areas of pasture within easy flight range from sources of blood, but the numbers taken were too small for analysis.

Correa (R. R.), Lima (F. O.) & Coda (D.). **Observations on the Flight and Longevity in Nature of** *Anopheles albitarsis domesticus*.—*J. nat. Malar. Soc.* **9** no. 3 pp. 280–284, 2 figs., 6 refs. Columbia, S. C., 1950.

Anopheles albitarsis domesticus Galvão & Damasceno is the vector of malaria at Iguape, on the coast of the State of São Paulo, but breeds mainly on Comprida Island, which is on the opposite side of a lagoon about 1,100 yards wide [*cf. R.A.E.*, B **36** 91]. It occurred in 18 out of 19 Anopheline breeding places (streams, ponds and borrow pits) found on the island and comprised all but four of the 5,036 Anopheline larvae collected, whereas it occurred in only six of 66 breeding places in Iguape itself and comprised only 46 of the 630 Anopheline larvae. In observations on flight range begun in March 1947, two females out of 4,700 adults of both sexes stained with methylene blue and released on the island were recaptured in houses at Iguape, nearly a mile away, 18 and 20 days after release, respectively. Of 2,240 mosquitos marked with a red bronzing powder and released at Iguape in 1948, 26 females were recaptured on the island and 12 adults were recaptured at other places up to 7½ miles to the east and 8 miles to the west of the place of release. The last date of release at Iguape was 19th March. The largest single recovery of marked females on the island was made on 20th May, when 17 were taken, and one individual was taken on the island on 15th June and one at Iguape on 23rd August. It is concluded that DDT sprays to leave toxic deposits must be applied not only in the localities to be protected but also in all dwellings situated within 12 miles of them.

Duret (J. P.). **Lista de los mosquitos de la República Argentina (Diptera, Culicidae).** [A List of the Mosquitos of the Argentine Republic.]—*Rev. Soc. ent. argent.* **14** no. 5 pp. 297–318, 47 refs. Buenos Aires, 1950.

A list is given of over 120 species of mosquitos, including 22 of the genus *Anopheles*, that occur in Argentina, with distribution records and indications of those recorded for the first time from the country or from a particular locality. It is stated in a note by Del Ponte that information received from A. L. Ayroza Galvão and A. C. Umana indicates that *Anopheles holmbergi* Del Ponte & Heredia [*R.A.E.*, B **36** 41] is a synonym of *A. fluminensis* Root.

Tischler (W.). **Malarialage und Mückenbekämpfung in Montenegro.** [The Malaria Situation and Mosquito Control in Montenegro.]—*Anz. Schädlingsk.* **23** pt. 5 pp. 65–69, 8 figs., 3 refs. Berlin, 1950.

The malarious districts of Montenegro are in the south-west and comprise an area to the north of Lake Scutari and several smaller ones on the coast, of which that round Bar was the most important. The main vectors are

Anopheles superpictus Grassi, which breeds in sunny pools formed in summer in the beds of dried-up mountain streams, particularly those covered with algae, and *A. maculipennis* Mg., which is a lowland species and bred in weedy irrigation ditches, ponds, and, near Scutari, in flood water. Both occurred near Bar. Six varieties of *A. maculipennis* were found, of which *typicus*, *messeae* Flni., *subalpinus* Hackett & Lewis, and *labranchiae* Flni., were present in both areas, and *sacharovi* Favr (*elutus* Edw.), which the author treats as a distinct species, and *fallax* Roub., which he considers to be probably identical with var. *atroparvus* van Thiel [*cf. R.A.E.*, B **29** 41; **31** 78; **36** 61], were taken in Bar. The other Anophelines observed were *A. claviger* (Mg.) (*bifurcatus*, auct.), *A. algeriensis* Theo., *A. hyrcanus* (Pall.) and *A. plumbeus* Steph.

Observations in 1944, when the spring was cool, showed that the first eggs of *A. maculipennis* were laid early in May, somewhat later than in normal years, and the new adults began to emerge towards the end of the month. Their numbers reached a maximum in late June and early July. *A. superpictus* began to oviposit about a fortnight later than *A. maculipennis*, and the new adults appeared soon after mid-June. They were most numerous from the end of July to September. Data for 1935–40 are given showing that malaria in children was most severe in Bar in August and September. Control measures undertaken in that district comprised clearing stream beds to avoid the formation of pools, dredging river mouths to allow the salt water to penetrate inland, clearing irrigation canals and improving drainage, filling in small ponds, and fitting taps to piped springs. In addition, breeding places were effectively treated with calcium arsenite mixed with road dust (1:50) and applied each week. The numbers of *A. superpictus* found in a house near a river at Bar, where extensive dusting was carried out, fell from 40 on 16th June to none from 17th July onwards, although it was abundant in districts where little or no control had been carried out. The larvivorous fish, *Gambusia patruelis*, also gave very successful control in water that was not rich in vegetation, and steps were taken to increase its numbers and distribution. As a result of the work, malaria became rare in Bar.

Lumsden (W. H. R.) & Buxton (A. P.). **A Study of the Epidemiology of Yellow Fever in West Nile District, Uganda.**—*Trans. R. Soc. trop. Med. Hyg.* **45** no. 1 pp. 53–78, 5 figs., 31 refs. London, 1951.

As the transmission cycle in wild primates and *Aëdes africanus* (Theo.) cannot alone account for the maintenance of the virus of yellow fever in an area with a pronounced dry season [*cf. R.A.E.*, B **41** 24, 25], investigations on the epidemiology of the disease were made in the West Nile District of Uganda, which, in some years at least, has a dry season of considerable severity and of 2–3 months' duration. It is an area of ridge-and-slope and wooded grassland with small patches of forest, mainly along rivers and on outcrop hills. Previous surveys of yellow-fever immunity in man, in which small numbers of protective sera were found mainly in the north and west, are reviewed. In the present survey, protective sera were found only in males, and were most numerous in populations living in close association with forest. A list is given of the local wild mammals thought to be of potential importance, with notes on their distribution and habits. Sera of eight out of 22 adult monkeys and of the only example of *Potamochoerus porcus* obtained were protective, but sera of 11 other wild non-primates were not. The results for non-primates are discussed in conjunction with previous findings. It is concluded that in West Nile District, as in other parts of Uganda, monkeys are important in the

epidemiology of yellow fever. The rate of immunity in monkeys here was lower than in Bwamba, and this is perhaps associated with the yearly reduction in the adult population of probable vector species of mosquitos as well as with a smaller and more localised monkey population.

A list is given of the mosquitos that, with *Chrysops centurionis* Aust., were taken in the West Nile District either as adults biting man at ground level or in trees, or as larvae. They included *A. africanus* and *A. simpsoni* (Theo.), which are proved African field vectors of yellow fever [**31** 61; **37** 150; **40** 52], *A. luteocephalus* (Newst.), *A. vittatus* (Big.) and *Mansonia* (*Taeniorhynchus*) *africana* (Theo.), which are proved laboratory vectors [**16** 236; **17** 213; **18** 147], and *A. aegypti* (L.). It is thought that *A. africanus* and *A. luteocephalus*, which bit mainly in trees, have a peak of activity after sunset and are thus adapted to attack monkeys in their night-resting positions, are the most likely local vectors of yellow fever. *A. aegypti* and *A. simpsoni* may also be concerned, but they seem much rarer as biting adults in the trees, although larvae of *A. simpsoni* are common in tree holes. *A. vittatus* was numerous in outcrop-hill forest, but was confined to ground level and so is not likely to be an important vector among monkeys. All the species that habitually breed in small containers, which include the proved African field vectors of yellow fever, were reduced towards the end of the dry season to at most a very small adult population biting man in forest. It is considered unlikely that the vector species breed continuously through the dry season in domestic containers, and it is inconceivable that the cycle in *A. aegypti* and man is responsible for the survival of the virus, as no immune women were found. It is, however, thought possible that transmission ceases in the dry season at least in some years and that virus is reintroduced from areas where the vector species can breed continuously.

Jackson (R. B.). **A Review of Investigations of the Habits and Pathogenicities of the common Anophelines of Hongkong.**—*Trans. R. Soc. trop. Med. Hyg.* **45** no. 1 pp. 91–101. London, 1951.

The situation, topography and climate of the Colony of Hong Kong are briefly described, and the habits and importance in disease transmission of the common Anophelines occurring there are reviewed from the annual reports of the Malaria Bureau for 1931–37. The four common Anophelines were *Anopheles maculatus* Theo., *A. minimus* Theo., *A. hyrcanus* var. *sinensis* Wied. and *A. jeyporiensis* var. *candidiensis* Koidz. Flooded fallow rice-fields were a source of *A. j. candidiensis* and *A. h. sinensis* at a camp in the New Territory of Hong Kong, and rice-fields when the second crop was ripening were a source of these two Anophelines at the same camp and on the Island. Both the localities in question were hilly. The results of precipitin tests and of dissections [*cf. R.A.E.*, B **23** 34; **25** 97] indicated that *A. maculatus* and *A. h. sinensis* have a marked preference for the blood of cattle, pigs and goats and transmit malaria only where these animals are absent or scarce, *A. minimus* or *A. j. candidiensis* being the important vectors in the Colony. All the four common Anophelines were efficient intermediate hosts of *Filaria* (*Wuchereria*) *bancrofti* [*cf.* **25** 98].

Rajindar Pal. **DDT Resistant Strain of** *Musca nebulo*.—*Trans. R. Soc. trop. Med. Hyg.* **45** no. 1 pp. 125–126, 1 ref. London, 1951.

The spraying of houses with DDT in each successive malaria season was begun in various parts of India during 1945, but enquiries in 1949 elicited no evidence of a consequent development of resistance to DDT in house-

flies. Moreover, adults reared in the laboratory from flies collected in three places near Delhi in which DDT had been applied during the four preceding years proved to be as susceptible to a DDT deposit as were those of a normal laboratory strain of *Musca nebulo* F. An attempt was then made to obtain a resistant strain from the normal laboratory one by exposing the adults of successive generations to a deposit of 12·5 mg. DDT per sq. ft. for 15 minutes and rearing from the survivors. It was observed that the flies developed a slight degree of resistance to DDT during the first three generations, but no further increase in resistance was observed in the next nine. At the third generation, the flies were 1·6 times as resistant as the normal strain, 75 per cent. knockdown being recorded in 51 and 31 minutes, respectively.

Burgdorfer (W.). **Analyse des Infektionsverlaufes bei** *Ornithodorus moubata* **(Murray) und der natürlichen Uebertragung von** *Spirochaeta duttoni*. [Analysis of the Course of Infection in *O. moubata* and natural Transmission of *S. duttoni*.]—*Acta trop.* **8** no. 3 pp. 193–262, 20 figs., 2 pp. refs. Basle, 1951. (With Summaries in English and French.)

The following is based on the author's summary. The anatomy of *Ornithodoros moubata* (Murr.) is described, and the results of observations on the development and behaviour of *Spirochaeta duttoni* in the tick are given in detail and discussed. They showed that if a tick feeds on an infected man or animal, the spirochaetes are carried with the ingested blood through the pharynx and oesophagus into the mid-gut, in the cavity of which they may be seen in gradually decreasing numbers for 16 days. They begin to gather on the periphery of the gut wall a few hours after the blood-meal, and penetrate through it into the body cavity after a minimum of 24 hours. The granules believed by some workers [*R.A.E.*, B **6** 138] to form part of the developmental cycle were not seen either in the gut contents or in the gut wall. There were some degenerated spirochaetes in the contents of the gut from the beginning of infection, but they were dead and had nothing to do with developmental stages.

Soon after the spirochaetes first reached the haemolymph, the numbers in it generally rose rapidly, owing partly to division and partly to the liberation of fresh spirochaetes from the gut wall. The time of onset and extent of the multiplication varied from tick to tick. From the haemolymph, the spirochaetes infiltrate into the various organs. They appeared at the earliest on the third day in the salivary glands, in the coxal organs and in the central ganglion and on the fourth day in the Malpighian tubes. They were not found in the lumen of the Malpighian tubes or in the anal excretions. They multiplied by simple and by multiple transverse division in the central ganglia, the coxal organs and the Malpighian tubes of both nymphal and adult ticks, but the salivary glands showed a strong permanent infection only in the nymphs. The salivary glands of the adults sometimes had heavy temporary infections but usually remained only slightly infected. The presence of granules such as Leishman and others described [*loc. cit.*] could not be confirmed in the organs mentioned or in ovules or mature eggs.

The behaviour of *S. duttoni* towards certain tick organs was also examined experimentally by introducing capillaries containing fragments of uninfected salivary glands, central ganglia and coxal organs surgically into infected ticks. All these organs were attacked by the spirochaetes in nymphal ticks but only the central ganglia and the coxal organs in adults. It is suggested that unknown substances in certain organs may attract spirochaetes in the haemolymph, and that the infiltration and perhaps also the multiplication of the spirochaetes depends on these substances, in which the central

ganglion and the coxal organs must be particularly rich. In view of suggestions that the development of *S. duttoni* is abnormal at temperatures below 25°C. [77°F.], the course of infection in the tick was studied at about 20°C. [68°F.]. The only effect of the low temperature was to reduce the activity of the spirochaetes and consequently retard the course of the infection. Living spirochaetes were still visible in the lumen of the gut 35 days after infection, and none was seen in the organs of the tick until the 13th day. No fragmentation of the spirochaetes into granules was observed.

Finally, the different ways in which *O. moubata* transmits the spirochaetes to warm-blooded animals were examined. It was demonstrated that infection can be transmitted by bite alone or by the secretion of infective coxal fluid, and that spirochaetes from the coxal fluid can penetrate unbroken skin. Transmission by bite alone is rare in the case of adult ticks.

DE TOLEDO (A. A.). **Contrôle do berne e das bicheiras com o BHC (hexacloreto de benzeno).** [The Control of *Dermatobia hominis* and Blowfly Larvae with BHC (Benzene Hexachloride).]—*Biológico* **16** no. 7 pp. 133–136, 1 ref. São Paulo, 1950.

Directions are given for preparing ointments containing BHC for application to cattle infested by larvae of *Dermatobia hominis* (L. jr.) in São Paulo [*cf. R.A.E.*, B **41** 35]. It is now stated that a content of at least 3 per cent. γ isomer is needed for complete mortality, and that ointments containing 1–2·5 per cent. do not kill the older larvae, though adults developing from them do not reproduce. A dust containing 2 per cent. γ BHC proved effective against blowfly larvae infesting animals when a pinch of it was applied to each larva, and the treatment prevented reinfestation of the wound for at least three days.

MANN F. (G.). **Dos nuevas sub-especies del *Anopheles pseudopunctipennis* Th. 1901.** [Two new Subspecies of *Anopheles pseudopunctipennis*.]—*Biológica* fasc. 8–11 pp. 33–42, 14 figs., 6 refs. Santiago de Chile, 1950. (With Summaries in German & French.)

Descriptions are given of the eggs, larvae and adults of both sexes of two new subspecies (*neghmei* and *noei*) of *Anopheles pseudopunctipennis* Theo.; they were found during studies of its ecology in the Province of Tarapacá, Chile, where it transmits malaria. They appeared to be restricted to oases (the Miñimiñe and Suca oases, respectively) that are completely isolated by desert, and rearing experiments showed that their characters are constant and not dependent on environment. Females of *A. p. neghmei* that developed from larvae in pools near dwellings showed a preference for human blood, whereas those from more remote breeding places fed for preference on native mammals, particularly small rodents. As irrigated land in the oasis of Suca is very limited in extent and is consequently always near dwellings, females of *A. p. noei* feed principally on man. It is believed, however, that all forms of *A. pseudopunctipennis* in Chile will readily attack the large domestic animals, especially horses and donkeys.

An illustrated key to the eggs of the seven subspecies of *A. pseudopunctipennis* now recognised [*cf. R.A.E.*, B **36** 53; **37** 177–178] is appended.

Heisch (R. B.). **Studies in East African Relapsing Fever.**—*E. Afr. med. J.* **27** no. 1 pp. 1–58, 1 fldg. table, 3 pp. refs. Nairobi, 1950.

A brief historical account is given of important discoveries on relapsing fever in Africa made up to 1918. The nomenclature of the spirochaetes causing the disease is discussed with special reference to those involved in the tick-borne form in East Africa. It is concluded that the latter are probably all of one type and conveyed by *Ornithodoros moubata* (Murr.), and the name *Spirochaeta duttoni* is used for all of them.

The distribution of relapsing fever in Kenya, Uganda and Tanganyika is reviewed. The main centres of the tick-borne disease are the Meru District and the Kikuyu, Nyanza and Taita Native Reserves in Kenya, where *O. moubata* has been found infected from sea level to an altitude of 9,000 ft., Ankole in the Western Province and Masaka in the Buganda Province of Uganda, and the Mwanza and Musoma Districts of the Lake Province, Biharamulo in the Western Province and an old endemic centre at Tabora in Tanganyika. An epidemic of relapsing fever transmitted by *Pediculus humanus humanus* L. (*P. h. corporis* Deg.) occurred near Mombasa in 1945 [*R.A.E.*, B **39** 75], and it is suggested that the louse may also be the vector of relapsing fever in Moyale where there have been several small epidemics [*cf.* **39** 19]. Recent work in Kenya that is reviewed comprises an investigation of the Mombasa epidemic [**39** 75], the discovery that an East African strain of *S. duttoni* can infect *P. h. humanus* and undergo metacyclic development in it [**39** 98], and the discovery of a previously unknown spirochaete in a grivet monkey (*Cercopithecus aethiops centralis*). This spirochaete, which was named *S. harveyi*, was infective to mice, rats and monkeys, but not to guineapigs or rabbits. A man inoculated with 0·75 cc. infected blood showed scanty spirochaetes on the 19th day for one day only, and no fever. Attempts to infect *O. moubata*, *P. h. humanus* and the monkey louse, *Pedicinus longiceps* Piaget, were unsuccessful.

Further experiments are described in which a strain of *S. duttoni* from the Meru District of Kenya and one from British Somaliland, both in monkeys, infected *P. h. humanus* as easily as the strain used in the work already noticed [**39** 98]. An attempt to infect lice with the Meru passage strain by feeding them on a man with spirochaetes in his blood failed, but three out of six batches of lice collected from the clothes of patients at Kisumu infected with *S. duttoni* and two lice (probably *P. h. capitis* Deg.) from the head of another proved infective on inoculation into animals 6–72 hours after collection. The discovery of natural infections in lice suggests that they may be an alternative vector. A classification of tick-borne spirochaetes according to their ability to infect lice is suggested. Experiments are described showing that *S. duttoni* can undergo metacyclic development in *Pedicinus longiceps* and that the infection can be transmitted by inoculation of emulsions of the lice.

Other arthropods that have been considered possible vectors of *S. duttoni* in nature are *Cimex hemipterus* (F.), *Argas persicus* (Oken), and, in particular, *Ornithodoros savignyi* (Audouin). The distribution of *O. savignyi* and *O. moubata* in Kenya is discussed. *O. moubata* almost always occurs in huts [*cf.* **36** 190; **37** 15] and *O. savignyi* out of doors [**39** 19]. Some 300 examples of *O. savignyi* comprising three batches taken under trees near infected huts in British Somaliland all proved non-infective in feeding experiments, whereas two of four small batches of *O. moubata* from British Somaliland, the progeny of one of them, and one out of 11 small batches from Kenya proved infective. Most of the examples of *O. moubata* were from huts where cases of relapsing fever had occurred. It is probable that *O. moubata* is the chief vector of relapsing fever in British Somaliland [*cf.*

(1335) Wt. P9/3884 8/53 E.P. Ltd. Gp. 566 [B] A

39 143]. However, *O. savignyi* was tested by feeding only, and an experiment with *O. moubata* is described showing that infected ticks may fail to transmit infection in this way. One of two batches of *O. savignyi* transmitted the Somaliland passage strain in the laboratory by feeding, whereas a single batch of 30 examples of *Argas persicus* did not. Spirochaetes were demonstrated in stained smears of *Cimex hemipterus* until the 12th or 13th day after an infective feed, and emulsified bugs were infective on inoculation until the 12th day, but the infection was not transmitted while biting.

In a search for animal reservoirs of *S. duttoni*, an examination was made of 241 rodents caught in huts at Kisumu and nearly all belonging to two varieties of *Rattus rattus*. All were negative, but *R. rattus kijabius*, the predominant variety, was extremely susceptible to laboratory infection with three strains. It is thought that there is no mammalian reservoir. Rats placed in wire cages in a hut infested with infected *O. moubata* did not acquire the infection, and no ticks were found feeding on them. In experiments with rats or mice and *O. savignyi* in the same receptacle, it was found that the rodents could protect themselves from adult ticks but not from nymphs.

There was no cross-immunity between most of the East African strains of *S. duttoni* examined, even when they were from the same locality, but many of the infections in immunised or hyper-immunised animals re-inoculated with other strains were short, and this may indicate a relationship between the strains. In contrast to heterologous strains, there was always cross-immunity between homologous ones. Cross-immunity reactions between known strains remained constant over long periods. Even passage through ticks or lice produced no change. No immunological differences could be demonstrated between first attack and first relapse spirochaetes. It is concluded that in spite of certain differences between strains of *S. duttoni*, they probably form a fairly homogeneous group.

A detailed account is given of an attack of relapsing fever suffered by the author. Large doses of penicillin curtailed relapses but did not prevent subsequent ones. Comparatively large doses of penicillin rapidly cleared spirochaetes from the blood of rats heavily infected with *S. duttoni*, but neither relapses nor residual brain infections were prevented. In experiments with pregnant rats infected with *S. duttoni*, there was only one instance of congenital transmission.

Henrard (C.) & Peel (E.). *Culicoïdes grahami* **Austen. Vecteur de** *Dipetalonema streptocerca* **et non de** *Acanthocheilonema perstans*.—*Ann. Soc. belge Méd. trop.* **29** no. 2 pp. 127–143, 16 refs. Brussels, 1949.

Dipetalonema (*Agamofilaria*) *streptocerca* is as widely distributed in man in the Belgian Congo as *Loa loa* and *Onchocerca volvulus*, and more so than *Wuchereria bancrofti*, but all these filariae are less widespread than *Acanthocheilonema perstans* and, unlike the latter, are concentrated in definite foci. It would seem that *A. perstans* occurs in all foci of *D. streptocerca*, and often outnumbers it in them. No clinical manifestations of parasitism by *D. streptocerca* were observed. The literature on species of *Culicoides* as vectors of filariae is briefly reviewed [*R.A.E.*, B **16** 155; **22** 58, 251; **28** 105]. It has been suggested that these midges transmit blood as well as dermal microfilariae, but the authors considered, on account of their short proboscis and tearing mouthparts, that it was more likely that they could transmit the dermal forms only. Similarly, scarification

of the skin with a lancet causes liquid containing dermal microfilariae to well up, whereas the presence of *O. volvulus* or *D. streptocerca* is only rarely revealed by deeper puncture with a needle.

An account is given of investigations to determine the vector of *D. streptocerca*, made at a mixed focus of this species and *A. perstans* in which the former predominated. There were few mosquitos, but midges of the genus *Culicoides* (nearly all *C. grahami* Aust.) were extremely abundant in the morning and evening. *Tunga* (*Sarcopsylla*) *penetrans* (L.) was found occasionally. In experiments in which females of *C. grahami* were taken while feeding on natives who harboured both filariae, often with a great preponderance of *A. perstans*, only *D. streptocerca* was ingested. It was ingested from a man in whom it had not been previously found but in whom the presence of a single individual was subsequently revealed after prolonged examination. It is concluded that xenodiagnosis is a practical means of detecting the presence of *D. streptocerca*. Sharp's grounds for identifying the microfilariae he saw in *C. austeni* C., I. & M. [**16** 155] as *A. perstans* are examined and found to be invalid. He apparently relied mainly on the fact that *A. perstans* was the only species that had been found in one of the donors. It is also suggested that Buckley may have been mistaken in assuming that microfilariae ingested by *C. furens* (Poey) were *Mansonella* (*Filaria*) *ozzardi* [**22** 251], which like *A. perstans* is a blood parasite. Development of microfilariae continued in *C. grahami* as Sharp described for *C. austeni* [**16** 156]. Natural infections were found in 1·2 per cent. of 737 individuals of *C. grahami* taken on man.

No development of *A. perstans* or *D. streptocerca* took place in *Simulium damnosum* Theo. The probable vector of *A. perstans* is discussed. It is presumed to be an insect with a long proboscis common in tropical regions. Among mosquitos, only the small species (*Culex* spp.) are thought to merit investigation [*cf.* next abstract]. Sausage-like forms and larvae of an unidentified nematode were observed in *T. penetrans*.

Wanson (M.) & Peel (E.). **Note sur le développement partiel d'***Acanthocheilonema perstans* **Manson chez divers culicides africains.**—*Ann. Soc. belge Méd. trop.* **29** no. 2 pp. 213–222. Brussels, 1949.

An account is given of investigations in the Belgian Congo designed to determine the vector of *Acanthocheilonema perstans*. No developing larvae were found in several thousands of *Anopheles gambiae* Giles, *A. moucheti* Evans, *Mansonia* (*Mansonioides*) *uniformis* (Theo.) and *Mansonia* (*Mansonioides*) *africana* (Theo.), but embryos were seen in the gut contents of 7–8 per cent. of *Mansonia*. It is concluded that the microfilariae taken up from the blood are eliminated with the waste material after digestion. Attempts at experimental infection were made with females of *A. paludis* Theo., *A. gambiae*, *A. moucheti*, *Culex perfidiosus* Edw. and *C. nebulosus* Theo. reared from larvae collected in nature and with *Aëdes aegypti* (L.) and *C. pipiens fatigans* Wied. from laboratory colonies. Particular attention was paid to *Anopheles paludis* and *A. moucheti*, which predominate in certain centres of population where indices of aperiodic microfilariae are high. *A. paludis*, *A. gambiae*, *A. moucheti* and *Aëdes aegypti* all acquired microfilariae of *Acanthocheilonema* when placed on the thigh of an infected volunteer 24 hours after emergence. Many more positive results were obtained in the cold, dry season than in the wet season. The reason for this is not known. Partial development was observed in a fair proportion of *Anopheles paludis* and in *A. gambiae* in the cold season, but only in one female of *A. moucheti* in the hot season. Development was slow, the

sausage forms reaching maximum size on the seventh day. All died between the ninth and 16th days. Subsidiary infective meals did not accelerate development of the filariae. No positive result was obtained with the species of *Culex*; they were tested in very small numbers in the wet season and dissected five or more days after the blood-meal.

Moignoux (J. B.). **Les onchocerques des equidés.**—*Acta trop.* **9** no. 2 pp. 125–150, 10 figs., 41 refs. Basle, 1952. (With Summaries in German and English.)

Onchocerca reticulata has long been known to infest the suspensory ligament of the pastern joint of horses, and opinions differ as to whether *O. cervicalis*, which infests the cervical ligament [*cf. R.A.E.*, B **22** 58; **24** 197], is distinct from it. The characters of the adults and microfilariae of both and their synonymy, prevalence and geographical distribution are reviewed, Steward's observations on the development of *O. cervicalis* in *Culicoides nubeculosus* (Mg.) are recapitulated [**22** 59], and the microfilariae of *O. reticulata* are described at length from the author's own observations in the south of France, where infestation of the legs of horses is frequent. The microfilariae were only rarely found in the blood and usually occurred in the lymphatic spaces and the sub-cutaneous connective tissue.

Extensive experiments failed to provide any evidence that *Simulium* spp. could act as intermediate hosts of *O. reticulata*. Some microfilariae were ingested, but these soon died in the gut. As horses were attacked by species of *Culicoides*, including *C. nubeculosus*, this midge, in which *O. cervicalis* develops, was chosen for special study. A natural infestation rate of 2·1 per cent. was found in it, and 29 per cent. infestation was obtained experimentally. In the south of France it appears in late March or early April and is most plentiful in May. Only one breeding place was found. This was in semi-stagnant fresh water near a marsh. In fine weather, the adults were most abundant between 4 and 6 p.m. and some could be seen between 9.30 and 11 a.m. They flew within about three feet of the ground and usually bit horses on the inner surface of the leg. Wet days were unfavourable to them, but they were more aggressive in thundery weather.

The development and growth of *O. reticulata* in *C. nubeculosus* is described. It occupied about three weeks at 25–30°C. [77–86°F.]. The microfilariae passed from the mid-gut to the thoracic muscles on the third day, the sausage stage was reached on the sixth day, there was a further change of shape with increase of length and decrease of width on the 14th to 18th days, activity then increased and a forward movement began, and some of the larvae reached the head by the 20th day. Development could take place at 16°C. [60·8°F.], and was not retarded until the thoracic muscles were reached. Individuals that had developed to the sausage stage at 25–30°C. survived at 16°C., but did not develop further until the midges were restored to normal conditions. At 10°C. [50°F.], which is about the threshold of activity of the insects, recently ingested microfilariae died in the thoracic muscles without increasing in size, and those that had reached the sausage stage died in 5–6 days. Because of the close similarity between the morphology and bionomics of *O. reticulata* and *O. cervicalis*, the author inclines to the view that they are identical. Lack of material made it impossible to test the theory by trying to bring about infestation of the cervical ligament with microfilariae from the legs.

Weyer (F.). **Die künstliche Infektion von Kleiderläusen und Mehlkäferlarven mit *Rickettsia conori* (Zeckenbissfieber).** [The experimental Infection of Clothes Lice and Mealworms with *Rickettsia conori* (Marseilles Fever).]—*Acta trop.* **9** no. 2 pp. 170–183, 10 figs., 4 refs. Basle, 1952. (With Summaries in French and English.)

The following is almost entirely taken from the author's summary. Lice (*Pediculus humanus humanus* L.) and young larvae of *Tenebrio molitor* L. were experimentally infected with a strain of *Rickettsia rickettsi conori*, by injecting suspensions of the lungs of mice containing rickettsiae, or of stomachs and body fluid of experimentally infected lice, into the haemocoele of the larvae and the haemocoele or rectum of the lice. In some of the tests, the blood of intranasally infected mice was used. The rickettsiae proliferated in the insects, and the strain was maintained in passage in the lice without losing its virulence for mice. After rectal infection, the rickettsiae multiplied rapidly in the epithelial cells of the stomach of the lice, and the cells became detached from their basis over the whole mid-gut in about 4–6 days. This led to an accumulation of the débris of the epithelium in the lumen of the stomach, which caused the death of the louse.

Gersdorff (W. A.), Nelson (R. H.) & Mitlin (N.). **Sulfoxide and 3,4-Methylenedioxybenzyl *n*-Propyl Ether in Pyrethrum and Allethrin Mixtures as House Fly Sprays.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 905–908, 6 refs. Menasha, Wis., 1953.

The effect of sulphoxide (n-octyl sulphoxide of isosafrole) and 3,4-methylenedioxybenzyl n-propyl ether added to kerosene sprays containing allethrin (94 per cent. pure) or pyrethrum extract (total pyrethrins containing 54 per cent. pyrethrin I and cinerin I) in an adjunct-insecticide proportion of 5 : 1 was compared in tests against *Musca domestica* L. by the turntable method [*R.A.E.*, B **26** 246]. Acetone at a non-toxic level was used as an auxiliary solvent for the sulphoxide. At the same concentration of insecticide equivalent (sum of the amount of insecticide and the product of the amount of the adjunct and its toxicity proportional to that of the insecticide), the mixtures of sulphoxide and pyrethrins and the ether and pyrethrins were 10·81 and 1·83 times as toxic as pyrethrins and the mixtures of sulphoxide and allethrin and the ether and allethrin were 2·32 and 1·44 times as toxic as allethrin. When the greater toxicity to *M. domestica* of allethrin as compared with pyrethrins was taken into account, it was found that, whether the principal toxicant only or insecticide equivalent was the basis for evaluation, pyrethrins plus sulphoxide formed the most effective spray, followed in order of decreasing effectiveness by allethrin plus sulphoxide, allethrin plus the ether, allethrin alone, pyrethrins plus the ether, and pyrethrins alone. The first mixture was nearly 12 times as toxic as pyrethrins on the first basis and nearly 11 times on the second. Knock-down was of a high order with all sprays.

Roberts (I. H.), Lofgren (J. A.) & Berndt (W. L.). **Tests with Insecticide Formulations for the Destruction of Cattle Grubs.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 909–913, 7 refs. Menasha, Wis., 1953.

A liquefied-gas aerosol containing rotenone and piperonyl cyclonene and various washes were applied to calves infested by third-instar larvae of *Hypoderma bovis* (Deg.) in South Dakota. The aerosol, which was applied directly to the cysts from a nozzle held two inches or less away, killed only

about 27 per cent. of the larvae. The washes were poured over the backs of the animals, which were then brushed for a minute with a stiff brush. Toxaphene, p,p'methoxy-DDT (methoxychlor), ryania and CS-708 [a mixture of one part 1,1-bis(p-chlorophenyl)-2-nitropropane, and two parts 1,1-bis-(p-chlorophenyl)-2-nitrobutane] were tested as substitutes for rotenone in washes, but were ineffective. A mixture of piperonyl butoxide and pyrethrins, when combined with rotenone (cubé), did not add to its effectiveness [*cf. R.A.E.*, B **38** 152], and sodium tripolyphosphate was not significantly better than soap in facilitating the penetration of rotenone into the cysts.

Furman (D. P.). **Control of the Northern Fowl Mite.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 926–930, 7 refs. Menasha, Wis., 1953.

The literature on the control of *Fonsecaonyssus* (*Bdellonyssus*) *sylviarum* (C. & F.) is briefly reviewed, and an account is given of laboratory tests in which the effectiveness of various materials against the mite was evaluated both off and on the host, and of field tests in California with the most promising materials. The most effective on the basis of laboratory tests was di(p-chlorophenoxy)methane (Neotran). When applied to the individual birds by hand so that it reached the skin under the feathers, a 10 per cent. Neotran dust eliminated infestations from adult fowls in field tests and apparently provided protection against reinfestation for at least 28 days. Treating adult birds as a flock with a hand duster did not ensure effective penetration of the dust among the feathers and so did not give control. Spraying flocks once with suspensions of Neotran at concentrations ranging from 0·5 to 2 per cent. gave erratic control, although infestations were usually markedly diminished. Further investigation of the method is warranted. Single, light applications of a 1·9 per cent. solution of nicotine sulphate with soap as a wetting agent reduced the mite population moderately but only temporarily. Thorough hand treatment of a moderately heavily infested flock with sulphur (325-mesh) gave effective control. A 5 per cent. dust of 2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite (Aramite) gave effective control of mites in laboratory tests on chicks, but no field tests were made.

Materials that showed some promise in the laboratory but were ineffective when applied as dusts to adult birds in field tests were 5 per cent. p,p'methoxy-DDT (methoxychlor), 5 per cent. DDT and 0·5 per cent. lindane [γ BHC]. Materials that showed only moderate to slight effect as dust formulations on the basis of laboratory tests were 10 per cent. p-chlorophenyl phenyl sulphone (Sulphenone), 10 per cent. di(p-chlorophenyl) methyl carbinol (Dimite), 10 per cent. p-chlorophenyl p-chlorobenzenesulphonate (Ovotran) and 1–10 per cent. toxaphene. Materials that caused mortality among chicks when applied as dusts were 10 per cent. toxaphene, 0·5 and 1 per cent. lindane and 2·5 and 5 per cent. chlordane.

Bailey (S. F.) & Bohart (R. M.). **A Mosquito Survey and Control Program in Guam.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 947–952, 1 graph, 6 refs. Menasha, Wis., 1953.

A severe epidemic of dengue occurred among members of the United States forces on Guam in September 1944, about a month after they had occupied the island, and then declined as the proportion of immunes increased and the rainy season ended. To organise control of the vector before the next rainy season, when fresh non-immune troops would have arrived, a

mosquito survey was carried out in January and February 1945. Nine species were found, all of the genera *Aëdes* and *Culex*. *A. albopictus* (Skuse) and *Anopheles subpictus* Grassi were not taken then, but were discovered on Guam in 1948. The breeding habits of the species found are briefly discussed. *Aëdes aegypti* (L.), the only known vector of dengue found in or before 1945, bred within 75 ft. of dwellings, preferably in rainwater partly shaded and free from road dust, in artificial containers and occasionally in tree holes. It bred along the west coast and throughout the agricultural areas in a wide band across the middle of the island, and occurred in 57 of 115 representative larval collections. It apparently disappeared rapidly from the neighbourhood of native huts when these were abandoned. Natives moving to new localities took infested containers with them, and the distribution of the mosquito could be accounted for mainly by spread in this manner.

The survey indicated that a control programme should consist of elimination of unnecessary breeding places and continuing treatment and inspection of the indispensable containers. Breeding places in order of choice were wooden buckets and bamboo sections, crockery (including flower containers), clean oil drums with one end removed (water barrels) and discarded tyres. The oil drums were the most numerous and could not be eliminated. Covers of burlap, unbleached muslin, double cheesecloth or scrap lumber were tried on them, and burlap in 30-inch squares proved the most practicable. It was treated with 5 per cent. DDT as an emulsified solution at 1 U.S. gal. emulsion for 60 squares. Rain carried minute amounts of DDT into the barrels, and in dry periods the mechanical action of removing and replacing the burlap dislodged enough impregnated fibres to keep the DDT content of the water at a level lethal to the larvae. Most of the covers observed individually remained effective for three months with one treatment, and all larvae died in 24 hours when water was poured through the cover at the end of this time. Most covers rotted within five months.

When the experimental work on covers was completed, a control programme was instituted in which potential breeding containers on refuse piles were sprayed with oil, burned or buried, scrap lumber and firewood were stacked off the ground, tree holes were filled with soil, water drums were covered with treated burlap or, if not needed, were overturned and perforated, and containers of water for fowls and livestock were emptied and sprayed if infested. During the rainy season, all areas had to be visited once a fortnight and a supporting educational programme was necessary. By September, 1945, the incidence of dengue and *A. aegypti* had reached vanishing point, and it later appeared that *A. aegypti* had been eradicated from the island.

It was also found necessary to take measures against three species of pest mosquitos. Excellent control of *A. vexans nocturnus* (Theo.), which bred in shallow fresh-water ponds, was obtained by treating them from aircraft with a 5 per cent. solution of DDT (prepared by diluting an emulsion concentrate with diesel oil), and when the same solution was applied to the breeding areas from the ground with a power sprayer before the heavy rains, it left enough deposit to kill larvae that hatched when the area was flooded. *C. pipiens fatigans* Wied. (*quinquefasciatus* auct.), which was found commonly in polluted water, was controlled by basic sanitation methods. *A. pandani* Stone was the most difficult to deal with, as it was necessary to treat from the air whole areas that included the *Pandanus* plants in which the larvae breed. The solution of DDT in oil was used at 0·4 lb. DDT per acre. Maximum protection lasted only 7–10 days after one such application.

Allen (N. N.) & Dicke (R. J.). **Cattle Lice Control by Clipping.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 970–973, 2 figs., 3 refs. Menasha, Wis., 1953.

An account is given of investigations made in Wisconsin during the winters of 1949–50 and 1950–51 on the effect of clipping on louse infestation of heifers in a herd in which Holsteins predominated. It was found that untreated infestations of *Damalinia* (*Bovicola*) *bovis* (L.), the dominant species infesting the animals, increased rapidly during the latter part of December, reached a peak by early February, decreased rapidly in late February and gradually during March and April, and had practically disappeared by 1st May. The heifers with long, coarse hair tended to have the heaviest infestations, and those with soft fine hair were practically free from lice. Clipping was effective as a means of controlling *D. bovis* for about two months, but on animals clipped two months before the peak of infestation, populations built up in the latter part of the season and sometimes reached a level higher than that on controls or persisted beyond the normal season of incidence. Population recovery on animals clipped one month before the peak followed the same pattern but at a much lower level. Recovery on animals clipped at the peak of infestation was negligible. The studies indicated that in Wisconsin a first clipping in late autumn or early winter followed by a second during early February should bring *D. bovis* under satisfactory control.

Limited observations indicated that *Solenopotes capillatus* End. is not so effectively controlled by clipping, though its numbers are reduced substantially. It appeared to be less sensitive to environmental differences due to clipping and to be able to thrive where *D. bovis* did not increase.

Cochran (D. G.), Grayson (J. M.) & Levitan (M.). **Chromosomal and Cytoplasmic Factors in Transmission of DDT Resistance in the German Cockroach.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 997–1001, 3 graphs, 19 refs. Menasha, Wis., 1953.

Literature on the inheritance of insecticide-resistance in insects is briefly reviewed, and an account is given of experiments on the resistance shown by the progeny produced in reciprocal crosses made between a DDT-resistant strain of *Blattella germanica* (L.) [*R.A.E.*, B **39** 167] and a susceptible strain when the resistant strain was in the ninth generation of selection and again when it was in the 11th generation. Some of the hybrids from the 11th-generation crosses were allowed to mate and produce an F_2 generation. The order of resistance of the various lots was determined by dipping adults in aqueous suspensions of DDT at different concentrations. The data obtained were examined statistically. The concentrations required for 50 and 90 per cent. kill and the degrees of resistance of each sex of the resistant strain and hybrids are given in a table; the F_2 hybrids are included among their parents. In the ninth and 11th generations, males of the resistant strain were 5·7 and 14·8 times, and females 66·6 and 333·3 times as resistant as those of the susceptible strain on the basis of median lethal concentration. The hybrids were intermediate in resistance between the members of the parent strains of the same sex. Hybrids of both sexes from crosses in which the female was the resistant parent were more resistant than those of the corresponding sex from the reciprocal cross. The data indicate that the inheritance mechanism for DDT-resistance in *B. germanica* is complex. Both chromosomal and extra-chromosomal factors seem to be involved, the former probably including both sex-linked and autosomal components. The extra-chromosomal factor is probably dependent upon nuclear genes for its propagation. The different ability of males and females to

survive treatment with DDT suggests a fundamental physiological difference between the sexes. Accentuation of this difference during selection for resistance may be due to sex-linked genes.

DeCoursey (J. D.) & Webster (A. P.). **Effect of Insecticides and other Substances on Oviposition by** *Aëdes sollicitans.—J. econ. Ent.* **45** (1952) no. 6 pp. 1030–1034, 2 figs., 7 refs. Menasha, Wis., 1953.

Oviposition by some insects, including house-flies [*Musca domestica* L.] and *Anopheles subpictus* Grassi, is known to be stimulated by ammonia [*R.A.E.*, B **4** 106; **23** 129] and the senior author has observed extensive oviposition by females of *Sitotroga cerealella* (Ol.) exposed directly to the fumes of ammonium carbonate. If mosquitos oviposited when exposed to strong ammonia fumes, which are lethal to them, the phenomenon might be termed a "death stress," and it might be expected that any death stress would cause oviposition. Studies were therefore made on the effect of seven irritant vapours and six insecticides on oviposition by females of *Aëdes sollicitans* (Wlk.) that had been collected in untreated areas and kept for 7–10 days at 80°F., during which time they were given sugar-water and daily blood-meals. The periods of exposure to the irritant vapours were those required to immobilise the mosquitos. The insecticides were applied as powders to the inside of flasks in which the mosquitos were exposed for 60 seconds. They comprised DDT, chlordane, aldrin, toxaphene, BHC and rotenone at concentrations of 0·5–5, 2, 0·25, 0·25, 0·2 and 2·5 per cent., respectively, in talc, and the controls were exposed to talc alone. After exposure, the mosquitos were kept individually in petri dishes, either for 24 hours with wet filter paper to provide favourable conditions for oviposition or for five hours with dry filter paper to provide adverse conditions. All the eggs laid after insecticide treatment in one of the tests under favourable conditions were kept on damp filter paper at 79–80°F.; some were immersed in water after six days to determine the percentages that would hatch and others examined for embryonic development after 13 days. Those that hatched and those that contained developed embryos were considered viable.

In the tests under favourable conditions for oviposition, none of the irritants (which included ammonia) significantly altered the number of eggs laid per female that oviposited, though the females that had been exposed to them oviposited while on their backs. Under the influence of the insecticides, 60–90 per cent. of the females oviposited, while 80 per cent. of the controls did so. A reduction in mean number of eggs per female was highly significant in the case of DDT (5 per cent.), chlordane and aldrin and not significant in the case of the other insecticides. The percentages of females ovipositing were significantly reduced by all concentrations of DDT, and the mean numbers of eggs per female were significantly reduced by the highest and one of the intermediate concentrations. The effect of the vapours on oviposition under unfavourable conditions was not studied, but that of the insecticides was marked. None of the talc controls oviposited, whereas the percentages doing so and (in brackets) the numbers of eggs per female among those exposed to toxaphene, aldrin, chlordane, rotenone, 5 per cent. DDT and BHC were 30 (7), 30 (15), 70 (42), 80 (57), 90 (89) and 90 (99), respectively. In the test with the eggs, the controls had the highest percentage viable (91) and the controls and rotenone the lowest percentage hatch (13). The viability and hatching percentages for the five synthetic insecticides were 55–86 and 22–31. This suggests that a speculative concept of forced hatching merits investigation. In a final test in which the heads of the mosquitos were mashed or severed from their bodies, oviposition started immediately and many eggs were laid over a period of 16 hours.

It is concluded that oviposition under insecticidal stress might contribute to the effectiveness of an insecticide if it occurred under conditions unfavourable for hatching, but that when a salt-marsh area is sprayed for the control of *A. sollicitans* the eggs would be laid in favourable conditions and as many mosquitos might be produced after a single spraying as there would have been without it.

Eddy (G. W.). **Effectiveness of certain Insecticides against DDT-resistant Body Lice in Korea.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 1043–1051, 4 refs. Menasha, Wis., 1953.

A high resistance to DDT in body lice (*Pediculus humanus humanus* L. (*P. h. corporis* Deg.)) in Korea, first noticed about December, 1950, was confirmed by studies during the summer of 1951, and laboratory tests with a number of alternative materials and formulations were begun. Head lice (*P. h. capitis* Deg. (*P. h. humanus* auct.)) taken from Koreans and Chinese were susceptible to DDT, showing typical DDT tremors before death, whereas body lice taken from the same individuals were not susceptible to DDT. Laboratory tests with various materials on patches of cloth [*cf. R.A.E.*, B **34** 44] indicated that body lice in Korea were about as susceptible to DDD (TDE), allethrin, pyrethrins, toxaphene, chlordane, γ BHC as lindane, aldrin and dieldrin as normal laboratory-colony lice at Orlando, Florida, had been found to be. The lowest concentrations at which these insecticides were completely effective were 1, 0·05, 0·05, 0·05, 0·01, 0·005, 0·001 and 0·001 per cent, respectively. Dieldrin, aldrin and chlordane were tested for comparative purposes only, as they are considered too toxic for use on man. Lindane might be safe to use at the low concentration needed.

In laboratory tests on the duration of effectiveness of dust mixtures, three containing 0·2 per cent. pyrethrins with a synergist, an antioxidant and 2,4-dinitroanisole [*cf.*, **34** 45] were somewhat superior to three similar ones in which allethrin was substituted for the dinitroanisole. Laboratory tests with a powder containing 1 per cent. lindane indicated that more than one treatment would be needed to eradicate lice under practical conditions. Other tests indicated that a 10 per cent. toxaphene powder might have enough lasting effect to eradicate lice in one treatment.

Two treatments at an interval of nine days with a powder containing 10 per cent. DDT and 0·2 per cent. pyrethrins caused only fair reduction of lice in small-scale field tests. About 2 oz. powder per person was applied by power duster or by hand from shaker cans. The latter method was more effective. The powder was applied to the clothing, but blankets and mats were not treated. The six powders containing pyrethrins with dinitroanisole or allethrin caused good reductions of lice in field tests after one treatment and almost complete eradication after three treatments. All six appeared equally effective. For practical use under conditions of heavy infestation, it is suggested that four treatments with pyrethrum powder be made at five-day intervals followed by weekly ones if reinfestations persist. It is recommended also that bedding as well as clothing be dusted where possible.

Repass (R. P.). **Laboratory Colonization of** *Aëdes triseriatus*.—*J. econ. Ent.* **45** (1952) no. 6 p. 1076. Menasha, Wis., 1953.

A strain of *Aëdes triseriatus* (Say) established in a Georgia laboratory from adults reared from larvae collected in the field and kept in tree-hole water has been maintained for several generations. Surfaces for oviposition were provided by putting blocks of dried oak wood (1·5 × 1·5 × 3 ins.)

horizontally in an enamel pan and adding tap water to a depth of about half an inch. The water level was maintained for about two days, after which the water was drained off and the blocks allowed to dry. Drying was gradual as the wood was well soaked, and when the blocks were re-submerged in tap water after thorough drying for several days, a high proportion of eggs hatched within 12 hours. The larvae were reared with negligible mortality in tap water with daily feedings of pulverised dog biscuit. The original females had to be fed on man, but those of subsequent generations fed readily on laboratory animals. Initial attempts to rear the species by providing bowls of pine or cypress wood for oviposition and allowing the water to evaporate were completely unsuccessful, as the eggs became desiccated. When attempts were made to rear collected larvae in tap water, mortality was high.

Severin (H. C.). **An unusual Infestation of Wood Cockroaches.**—*J. econ. Ent.* **45** (1952) no. 6 p. 1079. Menasha, Wis., 1953.

Parcoblatta pensylvanica (Deg.), which is normally common under loose bark, stumps and logs in South Dakota, was found in July 1951 to be infesting a jail on the top floor of a brick and stone building in Pierre. Adults and nymphs were numerous under lumber and crates on a verandah and on the roof of the verandah as well as in living rooms and cells. Lower floors were not infested. It is thought that the cockroaches must have been transported to the site in infested packages, as the females are nearly all short-winged and it is doubtful whether even the occasional long-winged ones can fly. The less likely explanation is that the females crawled up the side of the building. A 60-watt lamp was kept alight on the verandah from sunset until dawn.

Gray (H. E.). **Insects observed at Sea.**—*J. econ. Ent.* **45** (1952) no. 6 p. 1081. Menasha, Wis., 1953.

The author reports that large numbers of adults of *Musca domestica* L. appeared on a U.S. naval vessel, which was operating in an area 20–40 miles from the coast of Virginia during the daytime, soon after it anchored at 5 p.m. 22 miles from the nearest land for the nights of 12th and 13th August, 1952. No flies could be found on the ship during the day, and there were no places on board from which the flies could have emerged, very few ships in the same area, and no strong offshore breezes. He also records the finding of several adults of *Diabrotica undecimpunctata howardi* Barber and two of a species of *Chrysopa*, on the decks on the mornings of 13th and 14th August; these must have settled on the ship during the night.

Mitlin (N.), Gersdorff (W. A.) & Nelson (R. H.). **Toxicity to the House Fly of two Chlorinated Turpentines in Space Sprays.**—*J. econ. Ent.* **45** (1952) no. 6 p. 1083, 1 ref. Menasha, Wis., 1953.

Two commercially prepared compounds, a chlorinated sulphate-wood turpentine containing 63 per cent. chlorine and a chlorinated gum spirits of turpentine containing 60·3 per cent. chlorine, were tested as sprays in refined kerosene by the turntable method [*R.A.E.*, B **26** 246] for toxicity to *Musca domestica* L. Both were found to be about one-sixth as toxic as toxaphene (67·6 per cent. chlorine) and one-third as toxic as pyrethrins on the basis of the median lethal concentrations.

Roth (A. R.) & Hoffman (R. A.). **A new Method of tagging Insects with P^{32}.**—*J. econ. Ent.* **45** (1952) no. 6 p. 1091, 2 refs. Menasha, Wis., 1953.

In attempts to find a method of marking insects with radioactive phosphorus (P^{32}) that does not involve its addition to food or rearing media [*cf. R.A.E.*, B **39** 135, 181], spraying flies and mosquitos with aqueous solutions of radioactive phosphoric acid, with or without a wetting agent, in tightly closed chambers proved ineffective, but immobilising males and females of *Musca domestica* L. and *Phormia regina* (Mg.) with carbon dioxide, dipping them individually for ten seconds in a phosphoric-acid solution containing 5 microcuries P^{32} per ml., with or without 0·1 per cent. wetting agent (Triton X-100) and allowing them to dry was successful. The radioactivities of treated house-flies that were immobilised again and put 0·25 inches from the end window of a Geiger-Muller tube after one and four days were 233 and 181 counts per minute, respectively, when the wetting agent had not been used, and 1,750 and 920 c.p.m. when it had. The corresponding counts for *P. regina* were 333, 286, 3,717 and 2,800. Both males and females became radioactive. Radioactivity was increased by increasing the strength of the solution and the duration of dipping; the counts after 2, 3, 8 and 18 days when females were dipped for 60 seconds in a solution containing 12·5 microcuries P^{32} per ml. and 0·1 per cent. Triton X-100 were 2,250, 1,480, 744 and 433 for *M. domestica* and 5,900, 2,160, 2,000 and 700 for *P. regina*. The radioisotope could be washed off the flies, but only after long, vigorous shaking in water, and dissection revealed very little radioactivity within the body, indicating that the material did not penetrate the cuticle or enter through the spiracles.

Insects of several other orders were treated in the same way. All showed radioactivity to an extent depending on their individual size and the amount of cuticle wetted, and all survived the treatment except Aphids, which suffered high mortality.

Moore III (S.). **The Effect of Lindane Vapor on Canaries and Pigeons.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 1092–1093, 8 refs. Menasha, Wis., 1953.

An account is given of experiments in which four canaries and 75 pigeons were exposed to γ BHC as lindane dispersed by continuous vaporisation. The canaries were exposed in a room with an average temperature of 70–80°F., a relative humidity of 40–50 per cent. and closed windows. The common commercial rate of vaporisation is 1 gm. per 20,000 cu. ft. per day. When a rate of 1·6 gm. was maintained for 34 days, one canary became slightly ill while another remained healthy. The latter was re-exposed after an interval of 29 days to the high rate of 12·41 gm. intermittently on 15 days over a period of 43 days, being removed each time it became ill, and chemical analysis when it was killed 69 days after exposure revealed no lindane. No hypersensitivity was apparent. Another canary exposed to 2·47 gm. for 34 days became very sick but recovered in three weeks after removal to lindane-free atmosphere. The fourth canary, which was exposed to 14·02 gm., died after four days. A muscle extract gave complete kill in 24 hours of house-flies [*Musca domestica* L.] that fed on it. Pigeons varying in age from newly hatched to 10 years were treated in two lofts of open construction with good ventilation. High rates (3·10 and 20·55 gm. per 20,000 cu. ft. per day) were used to allow for this, and no pigeons were affected by exposure for 14 days at these concentrations, which are ample to control lice on the birds in 24 hours.

Schulze (F.), Sweetman (H. L.) & Spear (P. J.). **Toxicity of Lindane Vapor to tropical Fish.**—*J. econ. Ent.* **45** (1952) no. 6 pp. 1094–1097, 7 refs. Menasha, Wis., 1953.

Details are given of experiments in which high mortality of tropical fish of 13 species resulted when the aquaria containing them were exposed to and aerated with air in which γ BHC as lindane was vaporised at about 1 gm. per 6,000 cu. ft. per day for 55 days. Many fish died during the last month of this period and some during the ensuing months; mortality did not depend on size. Lindane was shown to be absorbed in aquarium water when only a small surface was exposed to contaminated air and no air was passed through it. Fish kept in water that had been contaminated showed lindane in the tissues for many weeks and recovery among fish removed to clean water was slow.

Berndt (W. L.). **The Chicken Mite attacking Children.**—*J. econ. Ent.* **45** (1952) no. 6 p. 1098. Menasha, Wis., 1953.

Mites that attacked children when they were playing in one room of a house in South Dakota were found to be *Dermanyssus gallinae* (Deg.). The mites were making their way to the room through the window from heavily infested birds' nests under the eaves. When the nests had all been destroyed, no more bites were received or mites seen. The bites were stated to have been painful, but no dermatitis resulted from them.

Knipe (F. W.) & Frings (H.). **An improved Cage for Flies.**—*J. econ. Ent.* **45** (1952) no. 6 p. 1099, 3 refs. Menasha, Wis., 1953.

To prevent the escape of flies during the servicing of laboratory cages, a method was devised whereby the cage is not opened after the pupae have been put in it. Water, and milk when needed, are supplied in wide-mouthed bottles covered with three or four thicknesses of cheese-cloth and inverted on the top of the cage. Once the cheese-cloth is wet, the fluids do not leak out, and the flies can reach the moist cloth through the screening. Sugar is scattered in cube form over the top of the cage. The females readily oviposit through the screening into medium in petri dishes inverted on top of the cage. If it is necessary to withdraw flies for experiment, they are lured by light into a bottle through a small hole in the top of the cage. *Musca domestica* L., *Phormia regina* (Mg.), and *Sarcophaga bullata* Parker have been successfully maintained in this way. Fermenting dog biscuit or moistened fermenting commercial mouse-diet was used as the larval medium for *Musca* and non-fermenting dog biscuit for the others. Fresh meat was provided for oviposition by *Phormia* and *Sarcophaga*, and this was transferred to rearing jars containing dog biscuit.

Swain (R. B.). **Smear EQ-335 to kill Torsalo Larvae.**—*J. econ. Ent.* **45** (1952) no. 6 p. 1101. Menasha, Wis., 1953.

An account is given of an experiment in which a commercial formulation (Smear EQ-335) containing 3 per cent. γ BHC as lindane and 35 per cent. pine oil gave 93 per cent. control of larvae of *Dermatobia hominis* (L. jr.) in tumours in the skin of cattle in Nicaragua [*R.A.E.*, B **41** 35].

[Kochergin (I.).] Кочергин (И.). **The Use of a Preparation of DDT for the Control of the Skin Botfly of Cattle.** [*In Russian.*]—*Veterinariya* **27** no. 2 p. 35. Moscow, 1950.

In a test on the control of the larvae of *Hypoderma* in cattle in the Province of Moscow in 1948, a 7 per cent. emulsified solution of DDT was brushed into the backs of the animals on 26th March, after the tumours had begun to appear, and the treated animals were subsequently kept in their sheds. The material was found to remain on the skin for 12–14 days. Tumours in the early stages of development subsided within the first few days and those in the half-way stage in 6–9 days; the larvae in fully developed tumours died in 2–3 days and the tumours subsided in 25–40 days. Some of the animals were treated again after 15 days, the material being applied only to tumours that had appeared since the original treatment, and it was observed that these subsided more rapidly than those first treated. The yield of milk was not affected. Two applications at an interval of 15–20 days, beginning when the first larvae reach the back, are recommended. This involves initial treatment in late February or early March for calves 1–2 years old and in mid-March for older animals.

[Makukhin (S. A.).] Макухин (С. А.). **Treatment of Domestic Animals and Birds with the Preparation SK-9.** [*In Russian.*]—*Veterinariya* **26** no. 10 pp. 46–47. Moscow, 1949.

[Kazakov (B. N.).] Казаков (Б. Н.). **Antiparasitic Action of the Preparation SK-9.** [*In Russian.*]—*Op. cit.* **27** no. 2 pp. 36–37. 1950.

It is stated in the first of these papers that SK-9 is an emulsion concentrate consisting of a highly chlorinated turpentine (SK [*cf. R.A.E.*, B **39** 157, etc.]) containing 54 per cent. bound chlorine, together with fish oil, spindle oil and emulsifiers. It proved effective in dips against *Psoroptes ovis* (Hering) on sheep at concentrations varying from 2 to 6 per cent. according to the severity of infestation, and was reported by veterinary workers to give good control of Anoplura and fleas on various domestic animals and Mallophaga on fowls when applied as a dip or wash at 2 per cent.

The experiments described in the second paper were designed to elucidate its mode of action and the optimum concentration for use in a spray against *Haematopinus suis* (L.) on pigs. The lice were not affected when they were suspended in muslin bags over 0·2–2 per cent. dilutions of SK-9 in test-tubes, even when heat was applied, but were immobilised for 15–30 minutes when placed on the back of a pig and sprayed with 0·3–2 per cent. dilutions; 0·2 per cent. had no effect. It is concluded that SK-9 has no fumigant properties.

In experiments under farm conditions, pigs sprayed with 0·3–2 per cent. SK-9 in water at a temperature of 15°C. [59°F.] were freed from lice within 15 minutes but the eggs were not affected and lice reappeared on some of the animals in 10–14 days. The lice were immobilised by the spray and dropped to the floor in 2–5 minutes, but recovered in 30 minutes and resumed activity. Motionless lice collected from the floor and placed on untreated pigs revived and remained on the animals, but those placed on treated pigs dropped off again. The 2 per cent. spray had no detrimental effect on the pigs, but was not noticeably more effective than the lower concentrations. Pigs sprayed with 0·2 per cent. SK-9 and examined 30 minutes later harboured mobile lice. Two applications of 0·5 per cent. SK-9 at an interval of 10–14 days are recommended. Since the lice are not killed, the pigs should be transferred to fresh quarters after treatment and

the infested sties thoroughly cleaned. Cleaning is facilitated by spraying the sties also.

[Khatin (M. G.).] Хатин (М. Г.). **A new curative Form of Bisethylxanthogen.** [*In Russian.*]—*Veterinariya* **27** no. 2 pp. 38–40. Moscow, 1950.

K soap, which is a mixture of equal parts of dixanthogen and soap, has proved effective in the Soviet Union against lice and mange mites on domestic animals [*cf. R.A.E.*, B **36** 169, etc.], but soap of the quality required for its manufacture is difficult to obtain. A different emulsifier was therefore sought for the dixanthogen, and a preparation termed K3 was developed. This contains 48–50 per cent. dixanthogen with sulphonated and naphthenic oils, or spindle oil neutralised with 30 per cent. sodium hydroxide. Unlike K soap, it does not corrode metals. When added to water, it forms emulsions that remain stable for several days. In laboratory tests with *Psoroptes bovis* (Gerl.), *P. equi* (Hering), *Sarcoptes bubulus* (Oudm.) (*bovis* auct.), and *S. caballi* Oudm. (*equi* Gerl.), a 6 per cent. emulsion of K3 heated to 40–45°C. [104–113°F.] killed all the mites in five minutes and proved as effective as 6 per cent. K soap.

The 6 per cent. emulsion also gave good results when applied to horses infested by *S. caballi*, *P. equi*, or *Chorioptes equi* (Gerl.), and cattle infested with *P. bovis*. It was warmed to 40–45°C. and brushed over the whole body of the animal, but in cases of severe infestation, it was applied locally to the affected parts and the crusts were removed from these before the general treatment, and a second application was made 2–3 days later. Neither horses nor cattle showed any ill-effects and there was a general improvement in their condition. Lice on domestic animals were controlled in three days by treatment with a 2 or 3 per cent. emulsion of K3 warmed to about 40°C.

Wanson (M.) & Holemans (K.). **L'habitat des stades préimaginaux de *Simulium neavei* et de *Simulium renauxi*.**—*Ann. Parasit. hum. comp.* **26** no. 1–2 pp. 93–98, 12 refs. Paris, 1951.

The authors refer to Edwards' record of the finding of the immature stages of *Simulium hirsutum* Pomeroy attached to *Potamon niloticum* (M.-Edw.) in Uganda [*R.A.E.*, B **16** 184] and state that they have found larvae and pupae of *S. damnosum* Theo. on *Potamonautes vandenbrandeni* Balss near Leopoldville. In both these cases, the association with the crabs was probably fortuitous, but in the case of the occurrence of the immature stages of *S. renauxi* Wanson & Lebied on *P. lueboensis* Rathbun in the Belgian Congo [**41** 62] and of those of *S. neavei* Roub. on crabs [*Potamon niloticum*] in Kenya [*cf.* **40** 5], it appears to be obligatory. However, a given Simuliid is not necessarily associated with a particular species of crab, since the distribution of *S. renauxi* in the Belgian Congo is wider than that of *Potomonautes lueboensis* and larvae and pupae have recently been found there on *P. lirrangensis* Rathbun, a crab of similar habits. To obtain adults, fragments of crabs' claw or carapace bearing mature pupae were put without water into glass tubes with cotton-wool stoppers, but successful emergence was rare, and adults usually had to be dissected from the cocoon. *S. neavei* and *S. renauxi* are closely allied, and both are vectors of *Onchocerca volvulus*, but *S. renauxi* can be distinguished by the delicacy and silver colour of the scales and by the black and hypertrophied femora and tibiae. Biologically, the distinction between the two rests on the altitude needed for the association with the crabs, which is 4,000–8,200 ft. for *S. neavei* in Kenya whereas the parts of the Congo where *S. renauxi* has been observed

associated with *Potamonautes* are not higher than about 2,600 ft. It is possible that *S. renauxi* is merely a variety of *S. neavei*. The Congo Simuliid with pupae with ten respiratory filaments tentatively identified as *S. neavei* by Grenier [**41** 49–50] seems to be an unnamed species.

[Zhivković (V.).] Живковић (B.). **Contribution to the Knowledge of the Breeding Places of** *Simulium columbaczense* **Schönb. (Golubatz Fly).** [*In Serbian.*]—*Arch. Sci. biol.* **2** pt. 1 pp. 51–52, 4 refs. Belgrade, 1950. (With a Summary in French.)

Investigations in Yugoslavia in 1949 showed that *Simulium* (*Danubiosimulium*) *columbaczense* Schönb. breeds not only in the stretch of the Danube between Golubatz and Kladovo [*cf. R.A.E.*, B **27** 85], but also further along the river to the west near Smederevo and to the east near Brza Palanka, though the larvae were not numerous at either of these places.

Roberts (F. H. S.). **Insects affecting Livestock with special Reference to important Species occurring in Australia.**—8½ × 5½ ins., vii + 267 pp., col. frontis., 138 figs., 9½ pp. refs. Sydney, Angus & Robertson, 1952. Price £A2 5*s*.

The main section of this work comprises an outline of the classification and morphology of the groups of insects and arachnids that include species that are pests, or vectors of diseases, of livestock and poultry, brief notes on the species of major importance in various parts of the world, and, in particular, concise accounts of the bionomics of those that are important in Australia and the measures applicable for their control under local conditions. Brief information on characters, adequate for the identification of some of the Australian pests, is given, and there are keys to the families of Diptera, the superfamilies of Acarina, and the species of fleas, lice, Muscids, *Gasterophilus*, Hippoboscids, Sarcoptoidea and ticks that are of veterinary importance in Australia.

The ways in which arthropods harm livestock, the losses they cause, the uses of insecticides against them and other methods of control are discussed in an introductory chapter, and directions for the collection and preservation of specimens for identification are given in an appendix.

Papers noticed by Title only

Floch (H.) & Abonnenc (E.). **Les phlébotomes américains. Clef d'identification de 97 femelles connues.**—*Ann. Parasit. hum. comp.* **26** no. 1–2 pp. 99–117, 95 figs., 1 ref. Paris, 1951.

Leleup (N.) & Lips (M.). **Notes descriptives complémentaires sur** *Anopheles rodhaini*.—*Rev. Zool. Bot. afr.* **44** fasc. 2–3 pp. 169–172, 4 figs., 1 ref. Tervuren, 1951. [*Cf. R.A.E.*, B **41** 30.]

O'Colla (P.). **The Analysis of chlorinated organic Insecticides by Partition Chromatography on Paper and on Cellulose Columns.**—*J. Sci. Fd Agric.* **3** no. 3 pp. 130–135, 3 figs., 36 refs. London, 1952.

[Mertin (J. V.).] **Pesticides Quarterly Supplement. Index to Supplements nos. 1–4, Feb.–Nov. 1952.**—pp. 263–271, multigraph. [Canberra] Dep. Hlth. Aust. [1953.] [*Cf. R.A.E.*, B **41** 77.]

Mertin (J. V.). **Pesticides Quarterly Supplement no. 5, February 1953.**—pp. 272–302, 60 refs., multigraph. Canberra, Dep. Hlth. Aust., 1953. [*Cf. R.A.E.*, B **41** 77.]

MARTINI (E.). **Lehrbuch der medizinischen Entomologie.** [A Text-Book of Medical Entomology.]—4th revd. edn., $9\frac{3}{4} \times 6\frac{3}{4}$ ins., xii + 694 pp., 318 figs., 27 pp. refs. Jena, G. Fischer, 1952. Price *DM.* 38.

In this new edition of a standard work on arthropods that are pests or vectors of diseases of man and domestic animals [*cf. R.A.E.*, B **12** 33] the matter has been somewhat rearranged and considerably expanded to include the results of recent research. The section on control, which includes a review of information on modern insecticides and is printed as an appendix, has been revised by W. Reichmuth, and that on fleas by F. Peus.

RIVERS (T. M.). Ed. **Viral and Rickettsial Infections of Man.**—2nd edn., $10\frac{1}{4} \times 7$ ins., xvi + 719 pp., frontis., 7 col. pl. (1 fldg.), 54 figs., 36 charts, many refs. Philadelphia, Pa., J. B. Lippincott Co., 1952. Price £3.

This work has been revised and enlarged to include information acquired during the four years that have elapsed since the publication of the first edition [*R.A.E.*, B **37** 195]. New chapters have been added on haemagglutination by viruses, interference between animal viruses, and diagnosis of infections by viruses and rickettsiae; and the chapters on diseases with the transmission of which insects are or may be concerned include one by J. L. Melnick & E. C. Curnen (pp. 338–358) on human infections caused by the Coxsackie group of viruses [*cf.* **41** 86], which have been encountered in many parts of the Western Hemisphere, as well as in Europe, Asia, Africa and Australia. The chapter on infections of minor importance is by J. Warren.

CHOW (C. Y.). **Note on the Time of Feeding of *Anopheles hyrcanus* var. *sinensis* and *Anopheles minimus* in the Vicinity of Chungking.**—*Chin. med. J.* **67** no. 9 pp. 489–490. Shanghai, 1949.

The time of feeding of *Anopheles hyrcanus* var. *sinensis* Wied. and *A. minimus* Theo. was studied near Chungking between September 1943 and October 1945. In each month from June to November in two years, mosquitos were caught every half hour from 7 p.m. to 5 a.m. on a buffalo in a stable and in a tent with human bait set up near the stable. Most of those on the buffalo were feeding, but many of those in the tent were not. The hourly catches for the different months are given in tables. The numbers taken on the buffalo before and after midnight were 511 and 159, respectively, for *A. h. sinensis* and 111 and 21 for *A. minimus*. Both appeared to feed most actively before 10 p.m., and few of *A. h. sinensis* and none of *A. minimus* were seen feeding after 4 a.m. The numbers of *A. h. sinensis* caught in the tent before and after midnight were 126 and 110; the total number of *A. minimus* was only eight. Both in the stable and the tent, the numbers of *A. h. sinensis* taken feeding were largest in June and July, whereas the largest numbers of *A. minimus* were in October and November. The number feeding was closely related to density. Precipitin tests indicated that both species fed mainly on cows and very rarely on man.

HSU (S. C.), FENG (L. P.) & CHANG (T. L.). **Observations on the Longevity of *Anopheles hyrcanus* var. *sinensis*.**—*Chin. med. J.* **67** no. 9 pp. 491–495, 1 graph, 3 refs. Shanghai, 1949.

A severe epidemic of malaria occurred near Chungking in 1940, and natural infection was subsequently found in *Anopheles hyrcanus* var. *sinensis* Wied. and *A. minimus* Theo. As a contribution to the study of their relative local

importance, the length of adult life of *A. h. sinensis* was investigated between May and November 1944. The mosquitos were caught in a cow shed and kept in batches of 250–300 in cages, each containing wet sand to provide moisture, water for oviposition and cotton soaked in sugar solution for food. Blood-meals on rabbits and rats were offered twice weekly.

The mosquitos were exposed to the various combinations of temperature and humidity occurring during the summer and autumn; the approximate mean maximum and minimum temperatures ranged from 32 and 24°C. [89·6 and 75·2°F.] to 15 and 12°C. [59 and 53·6°F.] and the relative humidities from about 60 to 90 per cent. The shortest and longest average durations of cage life were 3·5 and 10·8 days, and 25 per cent. of the mosquitos survived for over a fortnight only in autumn and during a short period in May–June. In general, the duration of life varied inversely with the temperature; it appeared that high humidity prolonged life at the highest temperatures but was of little importance at intermediate or low ones. The numbers of mosquitos in the cow shed fell suddenly when the mean minimum temperature dropped to about 15°C.

It is probable that the only periods in which appreciable proportions of the mosquitos live long enough for malaria parasites to develop in them are in May–June and autumn, and that the former period is too short to be of importance in malaria transmission. September and October are probably the important months, if the weather is not too dry for the mosquitos.

Holstein (M. H.). **Biologie d'*Anopheles gambiae*. Recherches en Afrique-Occidentale Française.**—*Monogr. Ser. World Hlth Org.* no. 9, 176 pp., 22 figs., 388 refs. Geneva, 1952. (With a Summary in English.)

The following is almost entirely based on the author's summary. This work comprises a review of available data on the biology of *Anopheles gambiae* Giles, together with details of the author's investigations on some special aspects of it, made over a period of two years in French West Africa. Notes are given on the climate of French West Africa and more particularly the Bobo-Dioulasso region (Haute-Volta), where most of the observations were made and laboratory experiments carried out. This is a savannah region characterised by a single rainy season with maximum rainfall in August–September and a long dry season from November to May, during which there are great variations of temperature over the 24 hours. The methods and techniques used for collecting, transporting, breeding and studying the mosquitos and studying the breeding-places of the larvae are described. Descriptions are also given of all stages of *A. gambiae*, and variations and their nature are discussed.

The types of breeding-places used by *A. gambiae* and their physical and chemical characteristics are reviewed. Existing classifications are considered unsatisfactory, and a division into organic and inorganic, according to whether the content of organic matter of vegetable origin corresponds to more or less than 1·25 mg. oxygen per litre after filtration, is suggested. Development from egg to adult was completed in 8–16 days in nature and 11–22 days in the laboratory. Its duration varied inversely with the temperature and directly with the content of organic matter in the water. Resistance of the early stages to such factors as extremes of temperature, desiccation and salinity enables the species to breed easily in very varied conditions.

Entry of adults into native dwellings began at about 7 p.m., and fell off before reaching a maximum between 11 p.m and 1 a.m. A second fall was followed by another peak between 3 and 5 a.m. Only one-eighth of

the total entered after 5 a.m. The curve of aggressiveness in the laboratory was almost identical with that for entry into dwellings. In a comparative study of host preferences, the females fed more readily on man than on monkeys or young pigs and much more readily on these animals than on rabbits and guineapigs. Study of seasonal variations in populations of *A. gambiae* and *A. funestus* Giles showed that either species may prevail during the whole year, though this is rare; more usually, *A. gambiae* predominates during the rains and is largely replaced by *A. funestus* in the dry season. Numerous examples are given, and annual variations and their causes are analysed. The results of investigations into the pseudohibernation or aestivation of females are set out. It is shown from observations in nature and in the laboratory that the females can survive the long, dry season by slowing down their metabolism; they take a blood-meal when the occasion offers, and can then develop their ovaries to stage V [*R.A.E.*, B **29** 93] without depositing eggs. A list is given of places in which females have been found during the dry season. They include dark corners of native huts, destroyed huts, crevices in rocks and holes in trees. In the laboratory, aestivation lasted up to 156 days, its duration varying inversely with the average relative humidity and average temperature. Blood-meals were withheld for 70 days without causing harm. The females become active and oviposit when the average relative humidity is kept above 80 per cent. This form of aestivation without the building up of fat reserves, characterised by suspended reproductive activity and optional feeding, is intermediate between gonotrophic concordance and dissociation.

In an examination of the part played by *A. gambiae* in the transmission of malaria, more than 12,000 dissections were made and showed that seasonal variations in the sporozoite rate followed seasonal population variations and were subject to the same influences (rhythm of rainfall and, particularly, relative humidity). Thus, it appears that *A. funestus* is responsible for most endemic malaria, whereas *A. gambiae* causes epidemic outbreaks or maintains very high endemicity within limited zones. Sporozoite rates in different localities varied between 0·8 and 30·7 per cent.

Larvae of the salt-water form (*melas* Theo.) of *A. gambiae* were found in localities on the coast of French West Africa in waters with salinities ranging from 0·1 to 53·2 gm. sodium chloride per litre [*cf.* **33** 32]. This form has been considered a species on the grounds of differences in salinity reactions, the morphology of the egg and larval pecten, and the occurrence of four bands on the maxillary palpi of some of the females [**36** 97, etc.], and also because of the sterility of males obtained in crossing experiments [**36** 98]. The characters of the eggs and adults are not constant, however [**34** 138–139], and the author found that some of the females of *A. gambiae* from fresh-water breeding places inland had four-banded palpi. Moreover, in cross-breeding experiments in Nigeria, matings between F_1 males and F_1 females were fecund, although the eggs laid did not hatch. On these grounds the author treats *melas* as a variety of *gambiae* differing in the larval pecten and in its breeding habits. The females tended to rest out of doors, had a maxillary index of about 15, and appeared to be zoophilous.

Details are given of investigations on the basis of which the author differentiates two forms of *A. gambiae* in French West Africa, one of which is anthropophilous and paucidentate (with 10–16 teeth per maxilla and an average maxillary index of 13·5), and the other zoophilous (feeding mainly on ox and antelope) and multidentate (with 12–19 teeth per maxilla and an average maxillary index of 15); they breed, respectively, in water with low and high contents of organic matter of vegetable origin. Recent work by Campbell has shown that two types of fresh-water *gambiae*, differing in

maxillary index and breeding habits, also occur in Gambia [**40** 41], and this supports the theory of the existence of two biological races in West Africa. Examination of captured adults proved that the paucidentate populations were considerably more exophilous (tending to use outdoor resting places) than the multidentate types. The criterion of exophily was the presence and number of males [*cf.* **15** 102]. Attempts to cross the two types were completely successful, the maxillary index being similar to that of the female parent in the F_1 females, but very variable in the F_2 generation. It is suggested that control measures should be directed against the adults in their outdoor and dry-season resting places.

The distribution of *A. gambiae* throughout the Ethiopian Region is reviewed in an appendix, reference being made to the main work carried out in each territory, and a list of collecting points in each of the French territories is given. Other appendices comprise data on sporozoite rates for *A. gambiae* in various parts of Africa and some of those in which it formerly recurred in Brazil [*cf.* **32** 159], and a key to the fourth-instar larvae and adults of the commoner species of *Anopheles* in French West Africa.

Covell (Sir G.), Russell (P. F.) & Swellengrebel (N. H.). **Malaria Terminology. Report of a Drafting Committee appointed by the World Health Organization.**—*Monogr. Ser. World Hlth Org.* no. 13, 82 pp., 7 figs., 33 refs. Geneva, 1953.

This report is a revision of one already noticed [*R.A.E.*, B **29** 92] with changes and additions to bring it up to date. The French equivalents have been omitted from the glossary.

The main change in the chapter on terms applied to the vector is an abridgement and generalisation of the subsection on nomenclature. It is stated that names of subspecific rank are accorded to certain Anophelines that have the character of species but, either because they are so nearly related to the species to which they are allocated, or for certain other reasons, are conveniently maintained as a group of subspecies rather than as so many distinct species. The abbreviation var. or subsp. before the subspecific name is not used in the example cited. It is pointed out that the term race is often employed to indicate subspecific differentiation not amounting to definable morphological distinction. It has something of the character of subspecies or variety but, whereas the essence of the latter distinction is morphological, the distinctions upon which races are based are usually genetic.

Reid (J. A.). **The *Anopheles hyrcanus* Group in south-east Asia (Diptera: Culicidae).**—*Bull. ent. Res.* **44** pt. 1 pp. 5–76, 13 figs., 1 diagr., 4 pp. refs. London, 1953.

Anopheles hyrcanus (Pall.) is one of the most variable and widespread Anophelines, and several of the forms by which it is represented in south-east Asia have been described and named, though only two, *sinensis* Wied. and *nigerrimus* Giles, were considered valid subspecies in the revisions of Edwards and Christophers [*R.A.E.*, B **21** 1, 280]. As a result of a study of Malayan material, the author gives descriptions of, and keys to, all stages of seven of them and considers that they form a group of sibling species. In addition to *sinensis* and *nigerrimus*, they comprise *indiensis* Theo., *peditaeniatus* (Leic.), *argyropus* (Sw.), *lesteri* Baisas & Hu [**26** 200], and *crawfordi*, sp. n. (*A. hyrcanus* pupal type B of Crawford [**27** 234]). The author accords them the status of species on the grounds that they are

sympatric but can be differentiated in all stages and breed true, no intermediates having been found. There is also fragmentary evidence of biological differences between them. He points out, however, that a problem of nomenclature will have to be solved if his view is accepted, since their identification is not easy and will certainly not be made in practical work. He therefore proposes the use of the name "*hyrcanus*" in inverted commas for any of the species of the group if its identification is uncertain and also for the group as a whole.*

The forms discussed include, in addition to the seven named ones from Malaya, one from northern Malaya not yet studied and provisionally called D2 and the Philippine *pseudosinensis* Baisas [**25** 29]. Characters are given for separating the larva, pupa and adult of the latter from those of *lesteri*. The *hyrcanus* complex appears to consist of at least two major groups, which probably have some small morphological differences distinguishing them, though it remains to be seen whether they are sharply distinct. The south-east Asian forms comprise one group; the other is palaearctic. There are at least two forms of *sinensis* in China, one belonging to each group, which overlap and perhaps interbreed. The complex formed by the very variable *A. coustani* Lav. in Africa is possibly a third group. The development of the south-east Asian forms by geographical and possibly sometimes by ecological isolation is discussed.

Notes are given on the bionomics of the various forms as observed in Malaya. As regards other places, little is known as it is not clear to which many of the records in the literature refer. The habits do not vary greatly. The larvae are found in swamps, rice-fields and similar situations in the open. Some breed in sunlit waters and their larvae are more often green than dark, others seem to prefer shaded places, though not in jungle, and their larvae are usually dark rather than green. There are indications that *sinensis* is usually green and that *nigerrimus* tends to be green or black. Most commonly, *sinensis* is found in open grassy ponds, sometimes on the coast, *nigerrimus* in deep ponds or swamps largely covered by plants, and *indiensis* and *peditaeniatus* in rice-fields. In Malaya, *lesteri* is almost confined to the coast, though one or two adults have been taken inland. Both it and *sinensis* can breed in moderately saline water. In the Philippines, *lesteri* is found inland as well as near the sea. The adults of the members of the group bite cattle for preference, but most will bite man freely out of doors shortly after dark, though they are reluctant to enter rooms in search of human blood. The degree of reluctance to bite man probably varies considerably between different forms. All can usually be caught at night at cattle sheds. The adults do not often rest indoors by day; *indiensis* has been recorded resting low down among ferns in light shade and *lesteri* has been found in hollows low down between the bases of old nipah palm fronds.

Forms referred to as *sinensis* and *nigerrimus* have been frequently recorded as infected with malaria, but it is not certain to which the records apply. There is evidence that *nigerrimus* has been a vector in several outbreaks, but except for *sinensis* in China, there seems little evidence to incriminate any of the others. In China, *sinensis* has been found infected with *Wuchereria bancrofti* [**28** 249] and has been experimentally infected

---

* This proposal is well suited to the needs of the author of an individual paper, but is less suited to those of an abstracting journal in which matter published by various authors, who differ in their views on the status and synonymy of the various forms, has to be collated and indexed. It is felt that clarity and simplicity in such a journal is best obtained by following the view that Anophelines of a closely related group should, for convenience, be treated as subspecies [see preceding abstract], and it is therefore proposed to cite the forms mentioned above as subspecies of *A. hyrcanus* in this *Review*.—Ed.

with *W. malayi* [**34** 66, etc.], and natural and experimental infection of *nigerrimus* (*hyrcanus X*) with *W. malayi* has been recorded in Borneo [**29** 165]. During recent investigations on *W. malayi* in Malaya (Kedah and Province Wellesley) about 1,000 females of "*hyrcanus*" were dissected and filarial larvae were found in five, of which four were *nigerrimus* and one was either *lesteri* or D2. In an experiment, *sinensis* was refractory to infection though it bit fairly readily, but larvae were found in 45 per cent. of 154 examples of *nigerrimus*, in 31–88 per cent. of smaller numbers of *lesteri*, *peditaeniatus* and *indiensis* and in all of five examples of *crawfordi*. Full-grown larvae were not found in *nigerrimus* earlier than 10·5 days after the infecting meal and the average number of worms per infected mosquito was only two, but it had the highest biting rate and may be important on that account.

Senior White (R. A.), Lewis (G.) & Lee (P.). **On Swarming and Mating in *Anopheles aquasalis* Curry.**—*Bull. ent. Res.* **44** pt. 1 pp. 163–173, 1 graph, 14 refs. London, 1953.

The following is substantially the authors' summary. In Trinidad, males of *Anopheles aquasalis* Curry swarm over open areas, mostly grass, and over drains, not over scrub vegetation. Swarming begins at a light incidence not exceeding 5 foot-candles. Pairing was seen in 65 of the 121 swarms observed, and of 115 females caught *in copula*, 75 had sperm in the spermatheca. The lag between the first sight of a swarm and the first observation of a mating pair averaged 6·5 minutes, the average light incidence when mating began being only 0·8 foot-candles.

Lewis (D. J.). **The Tabanidae of the Anglo-Egyptian Sudan.**—*Bull. ent. Res.* **44** pt. 1 pp. 175–216, 28 maps, 6 pp. refs. London, 1953.

Tabanids have an important effect on the stock-rearing inhabitants of the Sudan, largely by causing them to undertake extensive annual migrations to remove their animals from infested areas in the rains. The problems that will arise when economic development necessitates permanent settlement of certain infested areas are set out, and control is briefly discussed. No satisfactory measures have yet been devised. A list of the 68 named and two unnamed species known to occur in the Sudan is given, and the localities from which each has been recorded are cited and shown on maps. Their faunistic affinities, the types of country with which the better known species are associated, and distribution in relation to systematic position are briefly discussed, and the areas in which Tabanids cause serious harm to domestic animals by biting, and their seasonal prevalence, are indicated. Brief reference is made to certain habits, particularly the attraction of adults to inanimate objects such as cars and trains and the fact that certain species bite man in some circumstances and not others. The direct effect of bites, which is particularly severe in camels, is described, and notes, based mainly on the literature, are given on the part that the Tabanids probably play in the transmission of trypanosomiasis of cattle and of *Trypanosoma evansi*, which causes high mortality of camels but does not normally affect other animals in the Sudan, and on their relation to *Loa* (*Filaria*) *loa* [*cf. R.A.E.*, B **39** 176]. The effect that Tabanids have probably had on the distribution and annual migrations of pastoral tribes is also discussed. Additional information is given in notes on individual areas.

Transactions of the IXth International Congress of Entomology, Amsterdam, August 17–24, 1951. Vol. I. The Congress, Plenary Sessions, Communications at the Sectional Meetings.—lxi + 1115 pp., illus., refs. Amsterdam, 1952. **Vol. II. Symposia.**—vii + 364 pp., illus., refs. 1953.

The first volume contains the text of lectures given at plenary sessions and of most of the papers read at sectional meetings. Papers concerned with pests of actual or potential medical importance occupy some 100 pages, but the bulk of the information in them is of general character or has been noticed from other sources. The second volume comprises papers forming parts of symposia, and the following are abstracts of those in two of these symposia, which are concerned, respectively, with the *Culex pipiens* complex, and the development of resistance to insecticides in house-flies.

Mattingly (P. F.). **The *Culex pipiens* Complex** (pp. 285–287, 1 map). After briefly giving the main evidence that *Culex pipiens pipiens* L. and *C. p. fatigans* Wied. are hybridising sub-species [*R.A.E.*, B **40** 62–65], the author discusses the more confused status of the form that has been differentiated as *C. molestus* Forsk. [**40** 63, etc.]. It is morphologically similar to *pipiens*, from which it differs only in very inconstant colour characters and minor, somewhat inconstant structural characters affecting the male palps and the larval siphon [*cf.* **40** 63], but resembles *fatigans* in that it often bites man, breeds commonly in underground collections of water, cannot hibernate and pairs readily in small cages. Unlike either, it is autogenous. However, autogeny has been shown to be a Mendelian recessive [**40** 65], and at least in Cairo, one of the type localities of *molestus*, is found in only a small percentage of the wild population. In cage colonies, selection of autogenous strains is favoured by the environment. The author concludes that the facts are best fitted by assuming that the complex is a single species that has to some extent differentiated but that the intra-specific populations have not achieved reproductive isolation. Others, however, consider that *molestus* itself may be a complex of sibling species. To elucidate the situation, it is necessary to plot the geographical distribution of both morphological and biological characters and to ascertain the degree of reproductive isolation already attained by the members of the complex and the genetical basis underlying the various characters.

The cytological basis of inheritance in mosquitos of the tribe Culicini is unlike that in *Drosophila*. There is no differentiation of sex chromosomes. Hybridisation experiments with *Aëdes aegypti* (L.) and *A. albopictus* (Skuse) [**40** 105, etc.] have shown that the offspring are identical with the maternal species although back-crossing of the hybrids to the paternal species produces offspring of purely paternal type. Both *pipiens* and *molestus* can generally be readily crossed with *fatigans* in either direction, but [J. F.] Marshall, using one French and three British strains of *molestus*, found that these strains show very varying degrees of reproductive compatibility, and Laven, using continental strains, obtained comparable results [see next page].

Shute (P. G.). **Contribution to the *Culex pipiens* Complex** (pp. 289–291). The author gives an account of the discovery that *molestus* was breeding below ground level in London and biting man [**29** 18; **40** 67] and discusses the status of *molestus* and *pipiens*, which he is inclined to consider distinct species, in the light of this. He suggests that experiments with avian malarial parasites and members of the *pipiens* complex might provide valuable information. He also records that a strain of ? *molestus* from Cairo had been kept in the laboratory for a year and reached the 14th

generation without an autogenous batch of eggs being laid, but the females fed readily on man. Cairo *molestus* males and London *molestus* females paired readily in cages measuring 12 ins. cube and the females laid autogenous eggs. The hybrids were reared for five generations but laid no autogenous eggs, though copulation occurred readily. When Cairo *molestus* females were caged with London *molestus* males, only a small percentage of the females showed positive spermathecae. A few females laid a small batch of eggs following a single blood-meal, but most needed three blood-meals for oviposition, and even then only a small number of eggs hatched. Very few F_1 adults were obtained and the strain died out.

Laven (H.). **Genetical Aspects offered by the *Culex pipiens* Complex** (pp. 293–296, 2 figs., 1 ref.). Crossing autogenous strains of the *pipiens* complex from different localities in Europe gave progeny from both of the reciprocal crosses between London and Paris strains and between Hamburg and Harz strains. Between the London-Paris group and the Hamburg-Harz group, however, there was copulation and fertilisation but embryonic development was inhibited and no larvae hatched. Crossing males of an autogenous strain from Bodensee (Lake Constance) with the females of any of the other four gave a fully fertile F_1 generation, whereas the reciprocal cross resulted in inhibition of embryonic development. The production of fertile progeny in one direction only has been observed in other crosses, including that between *Aëdes aegypti* and *A. albopictus* [**40** 105–106, etc.], which are quite distinct morphologically. Three phenomena in these *Culex* and *Aëdes* crosses require explanation. These are the fertility of the progeny, the fact that the progeny in the *Aëdes* crosses are identical or virtually identical with the maternal species, and the fact that crossing is possible only in one direction.

The various degree of fertility in the offspring are in contradistinction to the results obtained in crossing members of the group of *Anopheles maculipennis* Mg. or species of *Drosophila*, in which the F_1 hybrids are wholly or partly sterile at least in one sex. The explanation must be sought in some chromosomal difference between *Anopheles* and *Drosophila* on the one hand and *Culex* and *Aëdes* on the other. In the first two genera there are more or less differentiated sex chromosomes, whereas in *Culex* sex is determined solely as a unifactoral character by a pair of genes in one of the autosomes. The sex chromosomes have been shown to play a decisive part in the production of hybrid sterility in *Drosophila*. Where these chromosomes are absent, such far-reaching disturbances in the development of the gonads cannot be expected.

Morphological identity between the F_1 hybrids and the maternal strain cannot be studied in *Culex*, as the strains used are not morphologically distinguishable. It is probably closely associated with crossing in one direction only. The F_1 adults are fully interfertile, and sometimes even show increased fertility. Back-crossing of the females is possible with males of both parent strains, but the hybrid males usually give progeny with females of the maternal strain only. In the back-cross to females of the paternal strain, most larvae die, though a few survive to yield viable adults, which may be of either sex and behave exactly like the paternal strain. Back-crossing of the progeny of F_1 females and F_1 males to the parent strains gives more viable offspring than the back-cross in the previous generation.

A hypothetical explanation, on the lines of that put forward by Smith-White [**40** 107] for the apparently similar case of *Aëdes*, is provided for the phenomena observed in crossing the Hamburg and Bodensee strains, depending on cytoplasmic factors in the two possible hybrids. Theoretically, both must receive the same set of chromosomes of half paternal

and half maternal origin, but this mixed chromosome set must produce the organism by acting on a Bodensee cytoplasm in one case and a Hamburg cytoplasm in the other. The combination is successful only in the case of the Hamburg cytoplasm. The diploid chromosome number in *Culex* is 6. The hybrid females therefore produce 8 kinds of eggs with different chromosome sets. Fertilisation and development of these eggs can take place with sperms of either of the original strains, since Bodensee chromosomes are successful in Hamburg cytoplasm. The F_1 hybrid males, however, produce a variety of genetically different sperms which, as a result of crossing-over, range from pure Hamburg chromosome sets to pure Bodensee sets, although both these extreme types are rare. It is only those few sperms with pure or almost pure Bodensee chromosome sets that can produce offspring that survive beyond hatching or in rare cases to the adult stage, when the back-cross is to the Bodensee female parent.

Knight (K. L.). **Suggestions for the Measurement of Variation in the *Culex pipiens* Complex** (pp. 297–298, 2 refs.). To determine the relationship between geographically separated populations in the *pipiens* complex, quantitative evaluations of variation must be made within small populations at numerous localities throughout the whole range of the complex, and the data so obtained must be correlated with geographical and seasonal distribution. So that the data may be adequately comparable, a small set of six morphological and four biological characters is suggested for study. The determination of the biological characters by accurate and easily standardised methods is not easy, and it is suggested that continued effort should be made to evolve suitable procedures.

Report of the Advisory Committee. International Co-operation to the Study of the *Culex pipiens* Complex (pp. 299–300). This is the unanimously agreed report of a committee set up at the end of the meeting to make recommendations regarding future research with particular reference to the standardisation of techniques and the securing of collaboration on an international basis. The morphological characters recommended for study are the DV/D ratio [**40** 187; **41** 15], the ratio of the length of the first four segments of the male palp to that of the proboscis, and the siphonal index of the fourth-instar larva.

Newman (J. F.). **Resistance of Flies to different Insecticides** (pp. 331–334, 4 graphs, 2 refs.). In Sardinia, DDT used extensively against Anopheline mosquitos at first gave excellent incidental control of houseflies [*Musca domestica* L.], but the development of a resistant strain of the latter led to the use of chlordane [**40** 195], which subsequently failed in the same way and was replaced by BHC. In small-scale field trials in the autumn of 1950, DDT, chlordane, BHC, p,p′methoxy-DDT (methoxychlor) and heptachlor all failed to give satisfactory fly control, and the resistance of the flies was confirmed by laboratory tests. A strain was reared in mass culture in England from flies brought from La Plaia in Sardinia, and experiments were made to investigate the distribution of resistance within the population, particularly to BHC. Deposits were prepared on the inside surfaces of 2-litre conical flasks by rotating in each flask 6 ml. of an acetone solution of the insecticide of an appropriate concentration, and drying in a stream of compressed air. About 100 flies were put into each flask, and the flask was then inverted on paper. Incapacitated flies fell on to the paper and were removed at intervals of two minutes. The times required for knockdown of flies of the La Plaia strain and of a normal laboratory strain thus exposed to pure γ BHC showed that the former included many individuals that were as susceptible as the normal strain, and also some that were more than five times as resistant.

Similar results were obtained when the resistance to BHC of a strain of *M. domestica* from Uruguay was compared with that of the laboratory strain, and the resistance of the resistant part of the population was quantitatively of the same order as that of the resistant flies of the La Plaia strain in so far as length of exposure is a measure of dosage. No knocked-down flies recovered within 24 hours. When exposed to DDT, however, flies of the normal strain and of two resistant Sardinian strains (La Plaia and Buggerru) showed no difference in the time at which knock-down took place, but some of the flies of the La Plaia strain and most of those of the Buggerru strain recovered in the following 24 hours, whereas no flies of the normal strain did so.

Knowledge on possible relationships between resistances developed to different insecticides is very incomplete. In various places, flies that have become resistant to DDT have been controlled for a time by other insecticides, but there is some evidence that resistance to DDT may affect resistance to related chemicals, such as methoxy-DDT. When flies of the La Plaia strain were exposed for the first time to dieldrin, the effect was in general similar to that of BHC. It would seem desirable to use the various available insecticides singly in sequence in any given area; the use of mixtures might lead to the simultaneous development of resistance to several of them. Results are given of tests with inbred strains selected from the La Plaia stock for resistance to BHC. All the strains tested in the F_1 and F_2 generations had then produced only resistant flies, but some produced both susceptible and resistant flies in subsequent generations.

Busvine (J. R.). **Laboratory Investigations with Insecticide-resistant Houseflies** (pp. 335–339, 1 graph, 10 refs.). A strain of *Musca domestica* obtained from Italy in 1948, after a DDT-spraying campaign, is shown to be about 16 times as resistant to DDT and five times as resistant to pyrethrins as normal flies, but to exhibit no resistance to nine other insecticides tested against it, whereas a strain originating in Sardinia in 1950, after DDT had been widely used for three or four years and also chlordane (and a little BHC), was 16 times as resistant as a normal strain of DDT and about 70, 50, 35, 9 and 10 times as resistant as the normal strain to chlordane, dieldrin, aldrin, γ BHC and toxaphene, respectively, but non-resistant to rotenone, pyrethrins or synthetic insecticides not containing chlorine. Simple criteria for assessing the resistance of a fly strain to DDT are the median lethal concentration of a drop of solution applied topically and the time required for knockdown by a deposit, but much care is necessary in interpreting the data. The solvent greatly affects the results of topical application; one of the Italian strains [the Sardinian one] was 16 times as resistant as the normal when the solvent was mineral oil and 300 times as resistant when the solvent was acetone. A volatile solvent is unreliable, because its evaporation leaves much of the DDT in crystals on the surface of the fly, one result being that the percentage of the DDT that penetrates is reduced as the concentration of the solution is increased. This fact is confirmed by data cited from the literature. Assessment by knockdown time has the disadvantage that, though measurement of the speed of action of the insecticide is desirable, resistance to immediate paralysing effect and to lethal effect are not always correlated. Only one of the two Italian strains was resistant to knockdown by DDT, but both were resistant to the lethal effect. The difference was not due to delayed penetration in one of the strains, since the same differences in immediate effect and similarity in kill were obtained when DDT was injected.

It has been shown that the faculty of tolerating insecticides is not acquired by individual flies by exposure to sub-lethal doses, but is due to a heritable factor. Most so-called resistant strains are not genetically pure

in respect of resistance, but some normally susceptible laboratory strains may be genetically pure, as a strain started with a few flies might fail to possess the resistance factor. This would explain instances of failure to obtain resistant strains by selection from laboratory cultures. When the gene or genes are present, however, selection causes a rapid increase in average resistance by eliminating the susceptible flies. So-called resistant strains must contain high percentages of flies with genes for resistance. The decline in average resistance of stocks maintained in the absence of DDT selection must be due to dilution by susceptible individuals. In individual crossing experiments by M. Harrison with reciprocal matings between males and females of resistant and susceptible flies, the F_1 generation was only slightly more resistant to knockdown than the normal strain, but the flies of the F_2 generation were sharply segregated into susceptible and resistant in the proportion of about 3 : 1. Back-crossing the F_1 generation with the "normal" parental stock gave all susceptible progeny and with the "resistant" parental stock a mixed susceptible and resistant progeny with a 1 : 1 ratio. All these results are consistent with a theory of inheritance of a single gene for resistance to knockdown, which is not completely recessive. As has been seen, resistance to knockdown is not always correlated with resistance to the lethal effect of DDT, which may be inherited by a different mechanism.

The results obtained by the various workers who have examined the theory that the DDT-resistance of a fly depends on its ability to metabolise DDT to a non-toxic ethylenic analogue (DDE) by splitting off HCl [**38** 209; **39** 211; **40** 56] are summarised in a table. They show that susceptible flies can metabolise very low doses of DDT but not high ones, and this raises the question whether the more efficient dehydrochlorination in resistant flies is the result and not the cause of their surviving longer. Moreover, resistant flies may still survive quantities of DDT far larger than those lethal to normal flies, while *Oncopeltus* [*fasciatus* (Dall.)], an insect not highly resistant to DDT, can metabolise it rapidly [A **38** 330]. It is possible that two or more protective mechanisms are involved. Experiments suggested that the Sardinian strain of *M. domestica* depends largely on metabolism of DDT and the other Italian strain more on an unknown mechanism.

Keiding (J.). **Development of Resistance in the Field and Studies of Inheritance** (pp. 340–345, 2 graphs, 4 refs.). When DDT was replaced by BHC and chlordane for the control of *Musca domestica* in Denmark in 1949, it was recommended that the two compounds should be used alternately at 0·1–0·2 gm. γ BHC and 1–2 gm chlordane per sq. metre. Nevertheless, high resistance to BHC was soon demonstrated [B **40** 115] and resistance to chlordane (and toxaphene) was demonstrated in July 1950 on a number of farms on the island of Lolland. In 1951, multi-resistance spread rapidly, and the flies on most farms in many districts, especially on the larger southern islands, could not be controlled with any of the synthetic chlorinated insecticides. In the remaining districts, resistance to BHC was common, but chlordane still gave good control in many places, even where it had been used alone for three years. Available information suggests that the geographical distribution of genes influencing resistance plays a part even in a relatively small area like Denmark, and that the insecticides used may be acting on different genetic material in various parts of the country.

Examples are given of tests on strains collected in different areas. High resistance to DDT was found combined with susceptibility to BHC, chlordane and toxaphene; very high resistance to BHC combined with susceptibility to chlordane and toxaphene and susceptibility to DDT in some

individuals and resistance in others; and high resistance to BHC, chlordane, dieldrin and toxaphene combined with susceptibility to DDT in some individuals and resistance in others. In the laboratory, a multi-resistant field strain lost some of its resistance to BHC in a few generations, without apparently altering its resistance to chlordane. This indicates a rather high degree of independence of the action of DDT, BHC and chlordane and of the resistance mechanisms, whereas resistance to chlordane seemed to be associated with resistance to dieldrin and toxaphene.

To study how the resistance characters are transmitted, P. Barbesgaard and the author made many crosses between resistant and susceptible flies and analysed the offspring for resistance to knockdown by DDT, BHC and chlordane. The results, which are to be published in detail elsewhere, indicated the action of a single factor determining the major differences in resistance to DDT, with susceptibility prevailing (but not fully dominant) over resistance. Susceptibility to BHC prevailed over resistance in the F_1 generation, as in the case of DDT, but with chlordane there was an intermediate resistance in the F_1 generation somewhat overlapping that of the resistant strain.

Rajindar Pal & Sharma (M. I. D.). **Laboratory Studies on the Development of a resistant Strain of** *Musca nebulo* (pp. 346–350, 2 graphs, 12 refs.). Results are given to the 24th generation of experiments designed to raise a strain of *M. nebulo* F. resistant to DDT. Knockdown time was recorded for all generations, and the results for the first 12 have already been noticed [**41** 95], but recovery in the 24 hours following knockdown was also considered in the subsequent ones. On the basis of knockdown time, the selected strain was not more than twice as resistant as the normal strain in any generation, but no normal flies survived for 24 hours after complete knockdown, whereas 16–39 per cent. of selected-strain flies of the 13th–24th generations recovered. In the 23rd and 24th generations, some of the flies were exposed for 15 minutes to glass panels sprayed with DDT water-dispersible powder at 50 mg. DDT per sq. ft. and kept under observation for 24 hours. None of the normal flies recovered, whereas 34 and 70 per cent. of the selected ones did so.

LaForge (F. B.), Gersdorff (W. A.), Green (N.) & Schechter (M. S.). **Allethrin-type Esters of Cyclopropanecarboxylic Acids and their relative Toxicities to House Flies.**—*J. org. Chem.* **17** no. 3 pp. 381–389, 12 refs. Baltimore, Md., 1952.

Since several cyclopropanecarboxylic acids esterified with the natural cyclopentenolones of pyrethrum flowers showed definite toxicity to cockroaches, whereas similar esters of aliphatic and aromatic acids not containing a cyclopropane group did not, the allethrolone (2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one) esters of some cyclopropanecarboxylic acids were tested for toxicity to adults of *Musca domestic* L.; they were dissolved in refined kerosene and applied as sprays by the turntable method [*R.A.E.*, B **26** 246]. The standard of comparison was natural pyrethrins; it had been shown by many previous tests that allethrin (the allethrolone ester of the *dl*-mixture of the *cis* and *trans* chrysanthemum monocarboxylic acids) is three times as toxic as this standard when compared by the turntable method.

The esters of 2-(1-methylvinyl)-, 2-(1-methylvinyl)-2-methyl-, 2-(3-methyl-3-butenyl)-2-methyl-, 2-(1-methylpropenyl)-3,3-dimethyl-, 2-propenyl- and 2-methyl-2-(2,2-dimethyl)propyl-cyclopropanecarboxylic acids, unsubstituted

cyclopropanecarboxylic acid, 2-furoic acid and 2,2-dimethyl-3-nitro-cyclopropanecarboxylic acid all proved less toxic than the ester of 2-isobutyl-3,3-dimethyl-cyclopropanecarboxylic acid (dihydrochrysanthemum monocarboxylic acid), which was about as toxic as natural pyrethrins. The ester of *d-trans*-chrysanthemum monocarboxylic acid had twice the toxicity of allethrin and was 50 times as toxic as the ester of *l-trans*-chrysanthemum monocarboxylic acid, showing that configuration in the acid component has an important effect on toxicity; it is possible that the slight toxicity of the *l-trans* ester may have been due to the presence of an impurity. The ester of *d-trans*-chrysanthemum monocarboxylic acid (type I) was 4·4 times as toxic as that of *d-trans*-chrysanthemum dicarboxylic acid monomethyl ester (type II), which corresponds with the relative toxicities of pyrethrins I and II and cinerins I and II [*cf.* **37** 67].

All compounds gave good knockdown, but less than natural pyrethrins or allethrin.

Gersdorff (W. A.) & Mitlin (N.). **A Bioassay of some stereoisomeric Constituents of Allethrin.**—*J. Wash. Acad. Sci.* **42** no. 10 pp. 313–318, 12 refs. Washington, D.C., 1952.

The results are given of investigations in which allethrin and four isomeric constituents of it were compared for toxicity to adults of *Musca domestica* L. by application in refined kerosene by the turntable method [*R.A.E.*, B **26** 246]. The fractions tested were mixtures of optical isomers and comprised the mixture of the two *dl-cis*-isomer pairs, that of the two *dl-trans* isomer pairs, the *α-dl-trans* isomer pair and the *β-dl-trans* isomer pair [*cf.* B **40** 116–117].

The *dl-trans* fraction proved to be 1·56 times as toxic as the *dl-cis* fraction, and as these exhibited similar action [*cf.* A **28** 200] when applied together, their proportions in allethrin could be estimated from their toxicities relative to it. The *trans* fraction was 1·33 and the *cis* fraction 0·85 times as toxic as allethrin, so that the *cis* isomers comprised about 69 and the *trans* isomers about 31 per cent. of the compound. The *α-* and *β-dl-trans* isomer pairs showed 0·35 and 1·69 times the toxicity of allethrin and constituted 8 and 23 per cent. of it, respectively. Since it has been shown that the mixed ester formed by the acylation of racemic allethrolone with *l-trans* chrysanthemum monocarboxylic acid has little or no toxicity [see preceding abstract], it is probable that the isomers formed from the *l-trans* acid with *l-* and *d*-allethrolone are nontoxic and that one of those formed from *d-trans* acid with *d-* and *l*-allethrolone is 0·7 and the other 3·38 times as toxic as allethrin. All the constituents tested caused high knockdown.

Jacobson (M.). **Constituents of *Heliopsis* Species. II. Synthesis of Compounds related to Scabrin.**—*J. Amer. chem. Soc.* **74** pp. 3423–3424, 5 refs. Easton, Pa., 1952.

In view of the high toxicity to house-flies [*Musca domestica* L.] of scabrin (the N-isobutylamide of an unsaturated 18-carbon straight-chain acid containing five double bonds [*cf. R.A.E.*, B **40** 15, 175], the N-isobutylamides of several C_{18} acids with fewer double bonds were prepared and tested. All proved to be ineffective at high concentrations, causing little knockdown or mortality.

Lindsay (D. R.), Stewart (W. H.) & Watt (J.). **Effect of Fly Control on Diarrheal Disease in an Area of moderate Morbidity.**—*Publ. Hlth Rep.* **68** no. 4 pp. 361–367, 6 figs., 6 refs. Washington, D.C., 1953.

As flies had been shown to be the vectors of *Shigella* in a part of Texas in which the morbidity and mortality from diarrhoeal disease are high [*R.A.E.*, B **39** 86], a study was made in Georgia on the effect of fly control on the incidence of diarrhoeal disease in an area where this was normally low or moderate and resultant mortality negligible. Three towns were treated and three others used as controls. Fly populations were measured with fly-grills [**38** 158], and a minimum of the five highest grill counts per sample block was recorded. *Musca domestica* L. outnumbered all other flies together at almost all times throughout the investigation. In the treated towns, all blocks were sampled weekly to determine the areas needing another treatment, and a town was treated again when the average of the five high grill counts exceeded three in any block. In the untreated towns, representative blocks were sampled. The prevalence of infection with *Shigella* and *Salmonella* was measured by making monthly rectal swab cultures of all children under ten in a representative population, and obtaining monthly histories of diarrhoeal disease in their families. At first, an emulsion containing 5 per cent. DDT was used both as a space spray and to leave a toxic deposit. The fly index (average of the third highest grill counts in all blocks) fell in the treated towns as each came under treatment in July–August 1949, while it continued to rise in the untreated towns. In November and December, there was a general fall, but warm weather in January caused a rise. Another treatment was necessary in February and again caused indices to fall in treated towns while they rose in untreated ones, but in May 1950 they rose sharply everywhere in spite of heavy applications of DDT in the treated towns, owing to high resistance to DDT developed in *M. domestica* and already revealed by laboratory tests.

Dieldrin was substituted for DDT in two of the towns and chlordane in the third. Both were applied in emulsions to leave deposits of 25 or 50 mg. dieldrin and 100 mg. chlordane per sq. ft. Almost complete control was maintained until late August, whereas the fly populations in the untreated towns increased greatly, but it then became evident from laboratory tests that *M. domestica* had become resistant to chlordane and dieldrin. The two insecticides selected flies with the same resistance factors. No dead or dying flies could be found where reapplications of chlordane or dieldrin had been made, and there was no appreciable difference between the mortalities of wild flies untreated and subjected in the laboratory to heavy deposits of dieldrin. Although DDT did not give satisfactory control of the resistant flies, dead and dying flies were easily found when further applications were made in October and November, and the mortality of wild flies subjected to DDT deposits in laboratory tests was significantly higher than that among controls. All marked failures in fly control were due solely to inability to kill *M. domestica*.

The rate of *Shigella* infection in children fell when fly control began and remained low from September 1949 to late August 1950. It rose again when effective fly control ceased, until, in and for a year after, October 1950, it somewhat exceeded the rate in untreated towns, which had continued at about original level throughout. The number of isolations of *Salmonella* was small, and was not influenced by fly control [*cf.* **39** 86]. The rates for diarrhoea in children were almost identical in the treated and untreated towns for the eight months before control began. The rate in the treated towns fell appreciably during effective fly control and rose again to slightly below that in untreated towns when fly control ceased.

Halverson (W. L.), Longshore jr. (W. A.) & Peters (R. F.). **The 1952 Encephalitis Outbreak in California.**—*Publ. Hlth Rep.* **68** no. 4 pp. 368–377, 16 figs., 1 map. Washington, D.C., 1953.

The largest outbreak of encephalitis so far recorded in California occurred in 1952, when 729 cases in man were reported in 37 counties between June and October (689 of them in the 20 Central Valley counties), and there were also 400 cases in horses. The history of the disease in California since 1938 is briefly reviewed, and an account is given of the organisation and administration of the control plan worked out to deal with the outbreak. The two viruses known to cause encephalitis in man in California are those of western equine and St. Louis encephalitis, and *Culex tarsalis* Coq. is believed to be the principal vector of both [*cf. R.A.E.*, B **36** 192, 194; **38** 193; **39** 101; **41** 66]. The very warm and wet weather of the previous winter provided optimum conditions for the building up of a large and widespread population of this mosquito, and the mild spring, as well as favouring reproduction, apparently prolonged the life of the adults. Moreover whereas *C. tarsalis* had previously been shown to be capable of flights of about two miles, it apparently flew 5–10 miles or more in 1952, and females entered houses to feed on man far more than usual. By July, irrigation waters had replaced natural waters as the principal breeding places. Resistance of *C. tarsalis* to DDT and other chlorinated-hydrocarbon insecticides, which had been demonstrated conclusively in the previous season [*cf.* **41** 48] appears to have played a significant part in reducing the effectiveness of the chemical control measures used. When the extent of the epidemic became evident in July and emergency measures were instituted, control was concentrated in towns and their suburbs to benefit the maximum number of people by the effort possible. The measures recommended were the frequent application of aerosol fogs, barrier spraying of a quarter-mile band on the periphery of each town, and intensive application of larvicides or correction of breeding places in towns and within two miles of them.

Chao (Pao-hsün) & Chung (Huei-lan). **Chinese estivo-autumnal Encephalitis (Epidemic Encephalitis).**—*Chin. med. J.* **69** no. 11–12 pp. 522–560, 4 graphs, 36 refs. Peking, 1951.

In addition to a review of literature on Chinese epidemic aestivo-autumnal encephalitis (which is apparently identical with Japanese B encephalitis), clinical and pathological data on 229 cases observed over the period 1942–51 in Peking, where the disease occurs annually and has been known since 1921, and a discussion of treatment and prevention, notes are given on the probable vectors. Ten species of mosquitos are recorded as breeding in the summer months in Peking; they include *Aëdes albopictus* (Skuse), *A. dorsalis* (Mg.), *Anopheles hyrcanus sinensis* Wied., *Culex tritaeniorhynchus* Giles, and *C. pipiens pallens* Coq. [which are experimental vectors of Japanese B encephalitis (*R.A.E.*, B **40** 162–163)] and *Aëdes chemulpoensis* Yam.

Huang & Cheng recently isolated a virus indistinguishable from that of Japanese B encephalitis from naturally infected females of *C. p. pallens* in Peking, but in laboratory experiments by Huang *et al.*, the virus of Japanese B encephalitis survived as long as 15 days in *A. chemulpoensis* and less than one week in *C. p. pallens*. Moreover, laboratory-infected females of the former readily transmitted the infection to white mice by biting, whereas the bites of the infected *Culex* females were innocuous. The breeding season of *A. chemulpoensis* coincides with the season of

greatest incidence of encephalitis (July and August), whereas that of *Culex* extends from early May to late October. Occasional cases of encephalitis have been recorded in May, June, October and November. Preliminary studies by Chang Nai-Ch'u and associates have shown that a considerable proportion of random samples of the sera of dogs, pigs and horses contained significant amounts of complement-fixing antibodies against the Japanese B virus. Recommended preventive measures include the usual ones for controlling mosquitos and protecting the population against their bites.

Nasiruddin (M.). *Phlebotomus argentipes* **found in Shimoga District, Mysore State.**—*Indian med. Gaz.* **86** no. 4 pp. 142–145, 4 maps, 18 refs. Calcutta, 1951.

The finding of *Phlebotomus argentipes* Ann. & Brun. in combined dwellings and cattle sheds in the Shimoga district, north-western Mysore, is recorded. The area under survey is in the extremely wet and heavily forested part of the State. No evidence was found that visceral leishmaniasis, which is believed to be transmitted by *P. argentipes*, occurs in this area, but the possibility of its introduction by immigrant labour from Bengal or Madras is suggested.

Downs (W. G.) & Bordas (E.). **Control of** *Anopheles pseudopunctipennis* **in Mexico with DDT residual Sprays applied in Buildings. Part V. Effectiveness of residual Applications of DDT and Gammexane up to one Year after Application under controlled Conditions.**—*Amer. J. Hyg.* **54** no. 1 pp. 150–156, 25 refs. Baltimore, Md., 1951.

This paper is the fifth of a series on the control of *Anopheles pseudopunctipennis* Theo. in the State of Morelos; the habits of the Anopheline in relation to houses and the design of the experimental houses used in the investigation were described in the fourth [*R.A.E.*, B **41** 88]. Three houses that contained approximately equal numbers of mosquitos in June and July 1949 were selected, and the adobe walls, ceiling and eaves of two of them were sprayed in September with suspensions of wettable powders containing DDT or BHC to leave deposits of 200 mg. DDT or 20 mg. γ BHC per sq. ft. Most observations were made at the season of greatest abundance in May–July 1950. At this time, both insecticides were still active and both showed an irritant effect, as 35·1 and 20·1 per cent. of the total number of mosquitos found in the houses treated with DDT and BHC, respectively, and only 2·5 per cent. of those found in the control house were taken in the exit trap in the night and early morning. All the remaining mosquitos in both treated houses were dead on sheets in the morning and all the remaining ones in the control house were taken in the exit trap in the evening exit flight. Of the mosquitos caught in exit traps in the DDT, BHC and control houses, 48·8, 84·8 and 24·3 per cent., respectively, died within 48 hours. The mosquitos irritated by DDT displayed a strong phototropism and tried vigorously to leave [*cf.* **35** 108], whereas those irritated by BHC flew about aimlessly. By September, the speed of action of the BHC was appreciably reduced. The total numbers of mosquitos in the DDT and BHC houses were 56 and 38 per cent., respectively, of the total in the control house. This may be evidence of a repellent factor operating over a distance [*cf.* **39** 149]. Experiments failed to reveal any evidence that spraying for four or five years had increased the resistance of *A. pseudopunctipennis* to DDT. The work described in this paper suggests that BHC, like DDT [**41** 80], will provide effective control of malaria transmitted by this mosquito.

Addison (C. C.) & Furmidge (C. G. L.). **Physico-chemical Studies on the Application of Insecticides to Sheep Fleece. I. Introduction to the Series.**—*J. Sci. Fd Agric.* **3** no. 7 pp. 315–320, 14 refs. London, 1952. **II. The Action of dilute Solutions of cationic Wetting Agents on Fleece.**—*T. c.* pp. 320–330, 7 graphs, 22 refs.. **III. The Action of micellar Solutions of cationic Wetting Agents on Fleece.**—*T. c.* pp. 330–336, 7 graphs, 7 refs.

The following is mainly based on the authors' summaries. The scope and aim of the experimental work described in this series are defined in the first paper. Significant factors in the formulation, effectiveness and mode of action of sheep dips are discussed, with special reference to bath depletion, the time factor and the influence of wetting agent, wool grease and suint, insecticide solvent and pH. Previous work is also reviewed.

In the second paper, an account is given of the behaviour of cationic wetting agents at concentrations below the critical level (near that for micelle formation) at which the reaction of natural fleece with them changes sharply. Cetylpyridinium chloride was chosen for the study because the C_{16} carbon chain is in common use in commercial wetting agents, and the chloride is more soluble and has a lower critical temperature for micelle formation than the bromide or iodide. Its critical concentration for micelle formation is 0·00085 M. (gram-molecules per litre). Measurements of its apparent removal from aqueous solution (termed "inactivation") by samples of fleece of Scotch Blackface sheep over periods of time show that such inactivation is considerable, even after one minute. The inactivation was determined from the decrease in the interfacial activity of the solution after contact with the fleece. High inactivation was due to grease and suint on the wool; cleaned fibres caused relatively slight inactivation. Suint influenced the interfacial activity of the solution by co-precipitation between the long-chain suint anions and the cetyl cations, and also by the introduction of inorganic salts. High adsorption, with some absorption, occurred at the grease surface. Consideration is given to the mutual interference between these two effects. The inactivation was directly proportional to concentration up to 0·0025 M., and was almost independent of the grease and suint content of the fleece; reasons for this, and possible implications are discussed. Since grease and suint, rather than the wool fibre itself, are responsible for inactivation and their chemical nature is probably common to all breeds of sheep, the conclusions reached with fleece of Scotch Blackface sheep should be applicable to other breeds.

A study of the influence of various samples of Scotch Blackface fleece on the interfacial activity of micellar solutions of cetylpyridinium chloride is described in the third paper. Inactivation varied considerably with grease and suint content of the fleece. The straight line obtained for the inactivation-concentration curve with dilute solutions finished abruptly at 0·0025 M. Inactivation then decreased rapidly until it reached a minimum of 0·004 M., and increased gradually at higher concentrations. The full inactivation-concentration curve can thus be divided into three distinct sections, and the mechanism of the reactions taking place in each concentration range is deduced from measurements of rate of change of fleece weight, pH and inactivation. When natural fleece is immersed in these more concentrated solutions, the system passes successively through the mechanisms typical of each section, *i.e.*, formation of a suspension of insoluble compounds of the cations and suint anions, with some adsorption to the grease on the fibres in the dilute section, solubilisation of some grease with formation of interfacially active complexes in the middle section, and flocculation and redeposition of suspension on to the fibres in the most concentrated section.

(1381) Wt. P9/3884 10/53 E.P. Ltd. Gp. 566. [B]

Knowles (F. A.) & Terry (E. D.). **Prevention of Tick-borne Relapsing Fever.**—*E. Afr. med. J.* **27** no. 2 pp. 88–93. Nairobi, 1950.

In the second half of 1947, all the houses in the township of Morogoro, Tanganyika Territory, were treated for the control of *Ornithodoros moubata* (Murr.) with D220 (Agrocide 7), a powder containing 2·5 per cent. γ BHC, which was mixed with Diatomite (Kensil F), a very light kaolin filler, in the proportion of 1 : 4. The dust was distributed from sprinkler-top cans to the whole floor area, cracks and the lower part of walls at about 3 lb. per 1,000 sq. ft., and a double quantity was used in areas shown by the preliminary survey to be very heavily infested or where the dust was likely to be rapidly lost. It had been found that cement floors and walls were as heavily infested as mud or burnt brick and, when cracked, more difficult to deal with. After 4–5 months, the tick population in treated houses had become negligible. Such reinfestation as occurred was due to fowls, the chief hindrance to the eradication of *O. moubata* from dwellings. After three months, treatment was extended to external domestic buildings, and as a precaution against heavy infestation during the rains when fowls and their owners would spend longer indoors, the whole town was treated again in January 1948 with half the original dosage. After that, only houses found to be heavily reinfested were treated.

From July 1947 to June 1948, 11 camps on local estates were treated, generally 2–4 times (but in two cases seven times at intervals of six weeks) with undiluted D034 (Agrocide 3), which contains 0·5 per cent. γ BHC. The physical properties of the dust were less satisfactory than those of the mixture used in the township, and the estates were more liable to reinfestation from introduced labour. However, the measures both in the township and on the estates were highly effective in reducing relapsing fever. The numbers of cases diagnosed at Morogoro Hospital in the five successive half years from January 1947 to June 1949 were 167, 96, 29, 16 and 7. In the last two years, nearly all the cases were on the estates. It is concluded that an initial full-scale application of the BHC and kaolin mixture followed by regular treatment with half the dosage every six months will keep domestic premises comparatively free from ticks and practically eliminate relapsing fever in a fairly static population.

Walton (G. A.). **Relapsing Fever in the Meru District of Kenya.**—*E. Afr. med. J.* **27** no. 2 pp. 94–98. Nairobi, 1950.

In the Meru District of Kenya, where about one-third of all Kenya tick-borne relapsing fever occurs, *Ornithodoros moubata* (Murr.) is almost confined to the Jombeni Mountains and one other small focus. A survey was therefore made to ascertain the reasons for its presence in the Jombeni Mountains and absence elsewhere. It was concluded that the local climate is in general too wet for the ticks and that they are most numerous and most likely to survive in the huts that have the driest and warmest floors, and particularly in those in which the beds consist of mud platforms instead of being raised on wood slats. It is thought that the universal adoption of raised beds would immediately reduce tick populations, and that these would be further lowered by regular cleaning (facilitated by the storage of food and implements in a separate hut) and by periodically puddling the floors and frequently scattering water over them. An attempt should be made to make alteration in hut construction and habits coincide with the use of BHC for control. The presence of animals in the huts reduced infestation, largely owing to compacting of the floor.

Jeffery (G. M.), Eyles (D. E.) & Young (M. D.). **The comparative Susceptibility of** *Anopheles quadrimaculatus* **and two Strains of** *Anopheles albimanus* **to a Panama Strain of** *Plasmodium falciparum*.—*J. nat. Malar. Soc.* **9** no. 4 pp. 349–355, 3 figs., 6 refs. Columbia, S.C., 1950.

In experiments in which the batches of mosquitos were fed simultaneously on a patient showing adequate densities of gametocytes of a Panama strain of *Plasmodium falciparum* and were examined for oöcysts after 11–13 days, the percentages of females infected were 79·9 in a Panama strain of *Anopheles albimanus* Wied. as compared with 62·1 in *A. quadrimaculatus* Say, 82·3 in a strain of *A. albimanus* from the Florida Keys as compared with 76·8 in *A. quadrimaculatus*, and 86·4 in the Panama strain of *A. albimanus* as compared with 81·2 in the Florida strain. The mean numbers of oöcysts per infected gut were 7·2 and 2·4 times as great in the Panama and Florida strains of *A. albimanus* as in *A. quadrimaculatus*, and 1·8 times as great in the Panama strain as in the Florida strain. There was probably no refractory part of the Panama *albimanus* population, but it appears that about 20 per cent. of the *quadrimaculatus* population was refractory.

Ryckman (R. E.) & Arakawa (K. Y.). *Anopheles freeborni* **hibernating in Wood Rats' Nests (Diptera: Culicidae).**—*Pan-Pacif. Ent.* **27** no. 4 p. 172. San Francisco, Calif., 1951.

Five out of some 20 Anophelines seen flying from the food and dung chambers of a nest of *Neotoma fuscipes* at Redlands, California, which was being examined in November 1950, were caught and found to be four females and one male of *Anopheles maculipennis freeborni* Aitken. Two of the females had recently obtained a blood-meal. Several of the mosquitos disturbed when the nest was opened made definite directional flights back into the remaining portions of the nest. In February 1951, three more nests were opened 150 yards from suitable breeding grounds and 300 yards from cattle and 9, 10 and 12 females of *A. m. freeborni* were found in them. Many were in the centre of the nest, and the majority had plump abdomens. None contained freshly ingested blood. It is concluded that nests of *Neotoma* should be considered when attempts are made to reduce the population of overwintering Anopheline females.

Downs (W. G.), Bordas (E.) & Correa Colorado (M.). **Malaria Control in the Southern Territory of Lower California.**—*Amer. J. trop. Med.* **31** no. 3 pp. 286–289, 2 refs. Baltimore, Md., 1951. (With a Summary in Spanish.)

Additional surveys of the Southern Territory of Lower California [*cf. R.A.E.*, B **40** 156] confirmed the presence of *Anopheles pseudopunctipennis pseudopunctipennis* Theo. as the only Anopheline. Inspection of many relatively inaccessible districts showed that while the country is nearly all desert, there are enough breeding sites scattered over an enormous area to make eradication much more difficult and costly than was at first anticipated, and it was abandoned as a policy. Four towns were sprayed with DDT in September–November 1948 and the same four and an additional one in March–May 1949. All houses, furniture, outbuildings and stables were treated at about 2 gm. DDT per sq. metre wall surface. Although larvae of *A. pseudopunctipennis* remained common in breeding

places, and adults could occasionally be caught inside houses, malaria had been reduced to vanishing point in all five towns by 1950.

Incidental control of flies [? *Musca domestica* L.], which had been good in 1948, was less satisfactory in 1949 and even poorer at the third treatment after the survey in August–September 1950.

Rickard (E. R.). **The Survival Time of the Rickettsias of Murine Typhus in infected Flea Feces.**—*Amer. J. trop. Med.* **31** no. 3 pp. 306–310, 9 refs. Baltimore, Md., 1951. **Attempted Transmission of Murine Typhus to Roof Rats by the Ingestion of Food heavily contaminated with infected Flea Feces.**—*T. c.* p. 311, 2 refs.

The following is based on the author's summaries. Samples of faeces from individuals of *Xenopsylla cheopis* (Roths.) that had fed for 18 days on roof rats (*Rattus rattus*) artificially infected with murine typhus were infective for rats by intraperitoneal inoculation and remained infective in a high percentage of cases until 48 hours after passage. Under the conditions of the experiments (storage at 75–95°F. with a relative humidity of 80–100 per cent.), only 20 per cent. of the samples tested after 72 hours and none of those tested after 96 hours were infective.

Food known to be contaminated with viable rickettsiae of murine typhus contained in infective flea faeces was ingested by 20 roof rats. Negative results in complement-fixation tests on the sera of these rats indicated that they remained uninfected.

Mohr (C. O.). **Entomological Background of the Distribution of Murine Typhus and Murine Plague in the United States.**—*Amer. J. trop. Med.* **31** no. 3 pp. 355–372, 8 figs., 25 refs. Baltimore, Md., 1951.

Data on the distribution of *Xenopsylla cheopis* (Roths.) in the United States are reviewed, and the distribution of murine plague (plague in domestic rats) and murine typhus is discussed in relation to it. In each of the areas in which plague has occurred among domestic rats or been contracted from them by man and in which surveys of *X. cheopis* have been made concurrently, the populations of this flea have been shown to be high and continuously distributed and the climate has been mild and humid. In surveyed areas in which no murine plague had occurred, populations of *X. cheopis* were low and intermittent. Even when rats have ample opportunity to contract plague from native wild rodents, they do not suffer epizootics if *X. cheopis* is not present to spread the disease among them. The distribution of murine typhus was similarly correlated with populations of *X. cheopis*, but was not quite so restricted as that of plague. There are three areas favourable to the existence of the two diseases on the mainland of the United States. These are a narrow strip along the Pacific Coast, the area around the Gulf of Mexico and the southern Atlantic Coast, and smaller and discontinuous extensions, particularly of the second area, up river valleys and in other favourable localities. As distance from the most favourable parts of the two main areas increases, numbers of *X. cheopis*, in general, decrease, distances between centres of high population increase, the isolated foci of infestation become smaller and less stable, and the percentage of rats infested also becomes smaller. Continuity of distribution of the flea population provides for a high rate of survival of plague infection, and sporadic distribution is unfavourable to it.

Brief reviews are also given of the distribution of *Nosopsyllus fasciatus* (Bosc) and *Leptopsylla segnis* (Schönh.). Plague occurring among domestic

rats at Tacoma, Washington, in 1942 was attributed to the former [*R.A.E.*, B **33** 133], but no plague was recovered from rats that were far removed from association with wild rodents and their fleas. No other outbreaks of plague or typhus have been reported in parts of North America where *N. fasciatus* is present but *X. cheopis* is uncommon. *L. segnis* and *Echidnophaga gallinacea* (Westw.) appear to be of no importance in the spread of either disease.

Longanecker (D. S.). **Laboratory and Field Studies on the Biology of the Relapsing Fever Tick Vector (*Ornithodoros hermsi* Wheeler) in the high Mountains of California.**—*Amer. J. trop. Med.* **31** no. 3 pp. 373–380, 5 refs. Baltimore, Md., 1951.

Relapsing fever in California is an enzootic rodent infection in the High Sierra and San Bernardino Mountains, and is transmitted to man by *Ornithodoros hermsi* Wheeler in rodent-infested houses [*R.A.E.*, B **35** 201, etc.]. To prevent infection of man in these areas it would be necessary to eliminate the rodents and ticks from houses, at first with poisons and permanently by rodent-proof building. Control of the tick is particularly important because laboratory tests have shown that it can remain alive and infective after several years of starvation, and a female tick can transmit the infection to a small number of its progeny [**24** 207]. Relevant aspects of the bionomics of the tick were studied in members of a colony established from 2,747 individuals collected in 1947 from rodent nests in snags (the standing remains of dead trees) in coniferous forests above 6,000 ft. Laboratory white mice served as sources of blood-meals in nearly all cases. Ticks from 18 of 39 snags produced relapsing fever in the mice by biting. The highest proportion of ticks proved to be infective in one snag was 19 per cent. of the number tested. In tests of transmission by larvae that were the progeny of seven infected females, positive results were obtained with the progeny of three. The total number of larvae used was 431, and 23 mice were infected, each by a batch of ten larvae, so that the minimum rate of transovarian transmission was 5·3 per cent. It was probably higher, however, as all the 11 batches of larvae from one of the females were positive. Two of these batches were therefore refed as nymphs, and 9 of the 20 nymphs produced relapsing fever in mice. Notes are given on the ecology of *O. hermsi* in the mountains of California. It is concluded that it is primarily a nest tick, usually associated with small rodents, but that it may perhaps feed also on bats and birds.

Davis (G. E.). **Observations on the Biology of the Argasid Tick, *Ornithodoros brasiliensis* Aragão, 1923, with the Recovery of a Spirochete, *Borrelia brasiliensis*, n. sp.**—*J. Parasit.* **38** no. 5 pp. 473–476, 1 fig., 4 refs. Lancaster, Pa., 1952.

Six females, three males and 22 nymphs of *Ornithodoros brasiliensis* Arag., were received in March 1951 from the State of Rio Grande do Sul, Brazil, where this tick is found in the soil under dwellings or shelters for domestic animals and has also been taken from the dens of a skunk (*Conepatus* sp.). They engorged very rapidly on white mice, but tended to remain attached for some time and pass copious coxal fluid. All the females mated, and three laid eggs that gave rise to 0, 3 and 110 larvae, respectively. These were very inactive when placed on the clipped belly of a mouse, but 15 took small amounts of blood after a time, and ten of them moulted in 7–28 days. The other five and 51 of those that did not feed

died without moulting, and all the rest had moulted unfed by about the tenth day after feeding was first attempted. It is concluded that feeding in the larval stage is exceptional. Moulting to the first nymphal stage after a period of days without feeding constitutes a new behaviour pattern for ticks of the genus *Ornithodoros*. After the first feeding, the ticks were kept singly in vials at room temperature and 79 per cent. relative humidity and fed individually after each moult. Throughout the nymphal period, the ticks fed readily within 48 hours of moulting. Moulting from the first nymphal stage took place in 8–10 days, but the range was wider in the later stages, being successively 12–34, 17–68, 20–63, 20–34 and 20–45 days in the next five. The males became adult after four or five nymphal stages, but two females did so after four, 13 after five, 12 after six, and one after seven, the last of which occupied 40 days. The first male emerged 103 days and the first and last females 120 and 184 days after the initial feeding. In all, 28 females and 18 males were reared to the adult stage, the progeny of one female. Of the females, 20 engorged and mated 1–3 times without oviposition. The original female fed and mated repeatedly but did not oviposit a second time.

A spirochaete was recovered from the blood of the host mouse six days after the first test feeding of one of the original nymphs and appeared again on the tenth and eleventh days. The strain was maintained by serial passage in mice but was lost after the seventh passage and was not recovered again from the tick. Spirochaetes appeared in the peripheral blood of two guineapigs six and seven and five and six days after injection of infective mouse blood, and there was one day of fever in each guineapig. There was little to distinguish the spirochaete morphologically, but as the locality is far from areas where spirochaetes are known to be present in other species of *Ornithodoros* and a remarkable degree of specificity has been noticed between ticks and their spirochaetes in the Western Hemisphere [*R.A.E.*, B **31** 177], the name *brasiliensis* is proposed for the species of *Spirochaeta* (*Borrelia*) normally transmitted by *O. brasiliensis*.

Davis (G. E.). **Biology as an Aid to the Identification of two closely related Species of Ticks of the Genus** *Ornithodoros*.—*J. Parasit.* **38** no. 5 pp. 477–480, 13 refs. Lancaster, Pa., 1952.

Ornithodoros turicata (Dugès) is a southern tick first described from Mexico and *O. parkeri* Cooley a northern species first described from Wyoming. *O. turicata* has been recorded in the literature from five counties (San Diego, Riverside, Madera, Kern and Alameda) in California, but biological studies on ticks from Kern and Fresno Counties identified morphologically as *O. turicata* indicated that they were *O. parkeri*, and a further morphological study by R. A. Cooley and B. C. McIvor confirmed this and indicated that all the ticks in the area, including the recently described *O. wheeleri* McIvor from Merced County [*R.A.E.*, B **26** 24], were *O. parkeri*, with which *O. wheeleri* was synonymised [**29** 145]. Ticks from Kern and Alameda Counties identified on morphological grounds as *O. turicata* and found to be infected with relapsing fever spirochaetes [**34** 153] were therefore examined by four biological criteria and shown by all of them to be *O. parkeri*. The criteria were the specificity of the relation between ticks of the two species and their respective spirochaetes [**31** 176], ability to transmit the spirochaetes through the egg, which occurs in *O. turicata* [**32** 63] but has never been demonstrated in *O. parkeri*, ability to transmit the rickettsiae of spotted fever by feeding and through the egg, which *O. parkeri* does [**32** 103] and *O. turicata* does not, and the presence of a rest period during the winter and early spring, which occurs in *O. parkeri* [**30**

89], whereas *O. turicata* is active throughout the year. Identification of one batch of ticks from Yolo County in 1948 as *O. parkeri* was confirmed by fulfilment of the first criterion.

Lockard (D. H.) & Fisk (F. W.). **A Turntable Modification of the Peet-Grady Method.**—*J. econ. Ent.* **46** no. 1 pp. 20–24, 14 refs. Menasha, Wis., 1953.

The modification of the Peet-Grady method of testing sprays against *Musca domestica L.* [*R.A.E.*, B **37** 5, 89] here described consists in exposing the flies in cylindrical cages of galvanised wire screen on a rotating turntable, which is set up in the centre of the chamber. The turntable is 48 ins. in diameter and 38 ins. from the floor and is made of masonite painted with black enamel to resist absorption of oil and insecticide. The Pect-Grady procedure is followed in applying the sprays and keeping the flies to determine mortality. With the turntable making 20 revolutions per minute, the Official Test Insecticide (OTI), 0·1 per cent. mixed pyrethrins in refined kerosene, consistently gave mortalities that fell within the 30–55 per cent. range specified for Peet-Grady tests. The average deposits of sprays containing the OTI received per fly by the turntable procedure were 1·61, 2·04, 2·28 and 2·92 mmg. with speeds of 0, 10, 15 and 20 revolutions per minute as compared with 6·16 and 6·75 mmg. with the large-group and small-group Peet-Grady procedures. There was more variation in the amount of spray deposited on individual flies by the standard method, but even the flies that were not knocked down received an average deposit greater than that necessary for knockdown with the turntable modification.

The median lethal concentrations of several synthetic organic insecticides as determined by the new method are given in a table; their toxicities were in the same relative order as they had been found to be when determined by standard methods, including the Campbell turntable procedure [**26** 246], the wind-tunnel method [**38** 148] and the large-group Peet-Grady method. Allethrin was only about 75 per cent. as toxic as the pyrethrins standard [the order of toxicity in this case being similar to that obtained in Peet-Grady tests (**40** 15, etc.) and the reverse of that obtained in tests by the Campbell turntable method (**39** 25; **41** 124)].

The turntable modification is not intended to replace the Peet-Grady method but is offered as an alternative. It provides a more rapid and economical method of testing sprays and, in contrast to the Peet-Grady method, it can be used irrespective of whether the insecticides do or do not cause knockdown, and also whether or not they leave a toxic deposit, as the test insect does not come into contact with the walls of the test chamber.

Hadjinicolaou (J.) & Hansens (E. J.). **Chlorinated Hydrocarbon Insecticides to control House Fly Larvae.**—*J. econ. Ent.* **46** no. 1 pp. 34–37, 2 refs. Menasha, Wis., 1953.

The following is based on the authors' summary. In laboratory studies, dieldrin, aldrin, chlordane and heptachlor were found to be effective against larvae of the house-fly [*Musca domestica* L.] when added to media in extremely small amounts, but in field tests on dairy farms in New Jersey, the use of the larvicides alone did not give adequate fly control because of the difficulty of finding all breeding places. Tests of the four insecticides on turkey manure and of dieldrin in a large manure pit on a dairy farm resulted in good kills early in the season, but progressively inferior kills

after each application. Laboratory studies of adults from the three farms where the tests had been made showed them to be resistant to chlorinated insecticides, including γ BHC (lindane), p,p′methoxy-DDT (methoxychlor), DDT, chlordane and dieldrin. Larvae reared from the flies also showed resistance to these materials. The strain from the dairy farm showed materially higher resistance than the two from turkey farms. It had probably been selected largely by dieldrin, as the treated manure pit was several hundred yards from the nearest point where other insecticides were used. It is concluded that the use of chlorinated-hydrocarbon insecticides against fly larvae results in much faster development of resistance (apparently in three or four generations) than does the use of the same materials against the adults [*cf. R.A.E.*, B **39** 39, etc.], and that it therefore has virtually no practical usefulness.

Goulding (R. L.), Curran (R. F.) & Labrecque (G. C.). **Insecticides for Control of Salt-Marsh Sand Flies in Florida.**—*J. econ. Ent.* **46** no. 1 pp. 37–43, 3 refs. Menasha, Wis., 1953.

Salt-marsh sand flies (*Culicoides*) are troublesome pests throughout the year in most of the coastal areas of Florida. The most abundant and annoying species, *C. furens* (Poey), breeds primarily in well-shaded marsh soils that are continuously wet with brackish water or are subject to daily floodings by high tides. Ditching, diking and pumping of marshes [*R.A.E.*, B **32** 20, etc.] have failed to control it satisfactorily. More recently, sprays of DDT applied from the ground or from aircraft have been widely used against the adults, and they usually give immediate relief, but applications must be made almost daily to keep annoyance at the minimum. Studies were therefore undertaken to determine whether the larvae could be controlled by treating the soil with insecticides. Chlordane and heptachlor were the most effective of those tested on small plots, both giving excellent control at 0·25 lb. per acre, and dieldrin, aldrin and γ BHC were highly effective at 0·5 lb. per acre. All were tested in emulsions and dieldrin as a suspension and as pellets also. Sodium arsenite in solution and lead arsenate, calcium arsenate and paris green as powders were relatively ineffective at rates of up to 4 lb. per acre, as were fuel-oil and creosote at about 40 lb. per acre in emulsions.

On plots of 0·2–5 acres, 1 lb. or more per acre of dieldrin, chlordane, γ BHC or aldrin in emulsion gave excellent reduction of larval populations within one week. Dieldrin appeared to provide the greatest and most consistent control over a long period, 1 lb. being effective for at least 44 weeks and 2 lb. for 65 weeks. Chlordane at 2 lb. and BHC at 1 lb. γ isomer per acre varied considerably in different tests; but sometimes gave control for long periods. Aldrin at 1 lb. per acre began failing between 21 and 28 weeks after application and was relatively ineffective after 43 weeks. DDT at 2 and 4 lb. and toxaphene at 2 lb. per acre gave poor immediate control and rather erratic results thereafter. Chlordane applied in an emulsion from aircraft to a 16-acre plot at 4 lb. per acre gave satisfactory control for 12 weeks and appeared to be about as effective as it was at 2 lb. per acre applied with ground equipment. In two experiments in which chlordane emulsifiable concentrate was dispersed by drip can in incoming tidewater in ditches to give 2 and 4 lb. chlordane per acre, respectively, and normal tide flow was checked by keeping the ditch outlets closed for 17 weeks, good reductions of larval populations were maintained for 38 and at least 51 weeks, respectively.

In practical control tests on mangrove marshes, dieldrin in emulsion applied with ground equipment on 92 acres of marsh at about 1 lb. per acre

gave excellent immediate control of larvae and was still almost completely effective after 20 weeks. Applications from aircraft of 2 lb. dieldrin in solution per acre showed similar results on two of three sections of a marsh with a total area of 125 acres, and control for about half as long on the third section where the direction and height of flight were such that less of the spray penetrated the thick mangrove. Light-trap catches of adults in these areas indicated that control with the ground treatment was good but not so good as appeared from the counts of larvae and that treatment from aircraft was less effective than ground treatment. They continued to show the presence of rather large numbers of *C. mellcus* (Coq.), which was subsequently found to breed almost exclusively in the sandy beaches of an inland waterway that had not been treated.

Gilbert (I. H.), Couch (M. D.) & McDuffie (W. C.). **Development of Resistance to Insecticides in natural Populations of House Flies.**— *J. econ. Ent.* **46** no. 1 pp. 48–50, 3 refs. Menasha, Wis., 1953.

Studies on the development of resistance to insecticides in populations of *Musca domestica* L. in dairy barns in central Florida [*R.A.E.*, B **38** 93; **39** 61] were continued in 1950 and 1951, when the increase in resistance in one season in flies in treated premises was investigated. Females collected from dairy barns were exposed on plywood panels treated with 25 mg. insecticide per sq. ft., and the exposure time needed to cause 50 per cent. mortality (LT50) was determined. The figures given below to indicate degrees of resistance are the ratios of the LT50 to that of flies of a standard laboratory strain. Flies from the dairy from which the sample least resistant to DDT had been obtained in 1949 [**39** 61] showed a marked increase in resistance in May 1950 and had developed resistance to other insecticides. They had a resistance of 12 to DDT and more than 12 to dieldrin, aldrin and γ BHC as lindane, but showed no resistance to p,p′methoxy-DDT (methoxychlor), parathion or pyrethrum. These observations were confirmed in space-spray tests, which demonstrated also that the flies had a resistance of 25 to chlordane. Sprays and aerosols containing lindane, dieldrin and pyrethrum were then no longer giving practical control in the dairy. By midsummer, the resistance of flies to DDT was more than 40. Three applications of dieldrin at 50 mg. per sq. ft. had been made in the dairy between 2nd June and 1st September 1949, but, so far as is known, neither lindane, aldrin nor chlordane had been used in the area.

Data on the resistance to various insecticides of flies collected from four dairies at different times in 1950 are summarised in a table. In a dairy that was being regularly treated with chlordane for the third season, resistance to DDT increased between spring and autumn, and a resistance to chlordane of 24 developed by the autumn, when there was also resistance to lindane. Deposits of chlordane in the dairy were effective in spring but relatively ineffective in summer and autumn. In another dairy, which had been treated with toxaphene in 1949, flies collected in spring showed no resistance to this chemical but were moderately resistant to DDT. After three applications of toxaphene during the season, the flies had a resistance of more than 65 to toxaphene and more than 10 to lindane. Spring and summer applications of toxaphene gave fairly good control, but autumn ones were ineffective. In a dairy where excellent control was maintained with DDT in 1948 and 1949, a high degree of resistance to DDT and lindane was shown in the autumn of 1950, both materials having been used during the season. Increased resistance to lindane and DDT at another dairy was indicated after several months of space spraying with lindane.

In 1951, flies were collected at irregular intervals during the active season

in several installations and tested by exposure to lindane and DDT with and without a synergist. The synergists were 2-hydroxy-decachloro-4,7-methanoindan-1-one with lindane and 1,1-bischlorophenylethane with DDT. All the flies from the five dairies for which results are given showed relatively low resistance to lindane, whether alone or with the synergist, in June and high resistance in autumn. All were highly resistant to DDT and moderately so to the DDT-synergist combination in June. Those from the dairy where resistance was lowest in June had increased their resistance considerably by September.

Collins (W. E.) & King (H. L.). **A modified Technique for Laboratory Evaluation of Contact Insecticides.**—*J. econ. Ent.* **46** no. 1 pp. 51–53, 5 refs. Menasha, Wis., 1953.

The authors describe a method of obtaining known deposits of insecticides on filter paper and of testing them on adults of *Tribolium confusum* Duv., and examplify it by an account of experiments in which the insecticide used was DDT in the form of a 50 per cent. wettable powder. The powder was kept in suspension in distilled water by an electric mixer, an aliquot portion was poured quickly on to a filter paper in a Büchner funnel, and the water was drawn off by vacuum. When the filter paper was dry, it was put in a vial; it was coated at the edge with vaseline to hold it to the glass and help to confine the beetles on it. Series of vials each containing ten beetles were stored in a rack that held them at an angle of 45° to prevent the beetles from crawling up the glass surface. After the required period of exposure, the beetles were kept for 7–8 days in vials containing a layer of whole-wheat flour and then placed on paper. Those unable to crawl were considered dead.

In tests in which the beetles were exposed for 1–24 hours to deposits of 14–229 mg. DDT per sq. ft. at 68–78°F. and 28–34 per cent. relative humidity, there were highly significant differences in the results given by the different deposits and by the different exposure periods. The exposure period appeared to be the more important, 40·7 per cent. mortality being given by exposure for one hour to a deposit of 229 mg. per sq. ft. or for three hours to one of 33 mg. When the beetles were kept before, during and after exposure at a constant temperature of 59 or 80°F. and about 33 per cent. relative humidity and were exposed to deposits of 33 or 61 mg. DDT per sq. ft. for three hours, mortality was significantly greater at the lower temperature in each case, but when they were kept at 80°F. and constant relative humidities of about 33 or 69 per cent., the same exposures resulted in no significant differences in mortality due to the different humidities, though the curve obtained by plotting the results indicated that significant differences might occur with other deposits of DDT. Adults 7 or 54–58 days old exposed to deposits of 33–122 mg. per sq. ft. at 80°F. and 69 per cent. relative humidity showed no difference in mortality due to age when the period of exposure was three hours, but mortality was very significantly higher for the older beetles when it was six hours. When treated filter papers were stored at room temperature and humidity for one day or one month before being used, storage time did not affect mortality after exposure of the beetles for three or six hours.

Yeomans (A. H.) & Rogers (E. E.). **Factors influencing Deposit of Spray Droplets.**—*J. econ. Ent.* **46** no. 1 pp. 57–60, 2 refs. Menasha, Wis., 1953.

The following is substantially the authors' summary. An account is given of tests to determine the requirements for applying sprays to leave toxic

deposits so as to obtain the best deposition of the toxicant with the least contamination of the surrounding air, and some of the basic factors influencing the behaviour of spray droplets and their deposition on surfaces are discussed. The test procedure consisted in determining droplet size, by collecting a sample on a slide and measuring the droplets under a microscope, and the percentage of deposit from measured amounts of sprays, by spraying against absorbent paper and weighing the deposit.

Nozzles of several types were tested, and all were found to deposit the spray on a surface in a similar way. Almost all the droplets from sprays directed downwards were deposited. When the sprays were directed horizontally towards a vertical surface, the amount of deposit decreased as the distance between nozzle and surface increased; the decrease was gradual as the amount fell to about 75 per cent. and was then rapid. The deposit was greater when enough spray was released to generate an air stream in the direction of the spray, and the distance at which 75 per cent. of the spray was deposited was greater with larger droplets, narrowed spray angle or greater output. In sprays directed upwards, the effective distance between nozzle and surface was greatly decreased.

The results demonstrated that the distance between nozzle and surface should be limited to that which will permit 75 per cent. or more of the spray to be deposited and that the mass median diameter of the droplets should be at least 50μ, to minimise the drift of undeposited spray.

Pfadt (R. E.), Paules (L. H.) & DeFoliart (G. R.). **Effect of the Sheep Ked on Weight Gains of Feeder Lambs.**—*J. econ. Ent.* **46** no. 1 pp. 95–99, 2 graphs., 7 refs. Menasha, Wis., 1953.

The effect of infestation by the sheep ked, *Melophagus ovinus* (L.), on gains of weight in lambs that were receiving rations including barley, lucerne hay and beet pulp, was studied for three seasons in Wyoming. The feeding period lasted about 100 days. No significant differences in gains, mortality or amount of food consumed were observed between untreated batches of lambs and batches on which the keds had been controlled by dusting with 0·5 per cent. rotenone as cubé or 1 per cent. dieldrin [*cf. R.A.E.*, B **40** 192; **41** 73]. Although infestation was moderate to heavy at the start of the trials, the numbers of keds on the untreated lambs declined after the lambs had been on feed for a few weeks, whereas the numbers on range flocks at the same time were increasing. Possible reasons for the fall in the numbers of keds on the lambs receiving feed are discussed. No evidence was produced that controlling keds on such lambs was profitable.

Grayson (J. McD.). **Effects on the German Cockroach of twelve Generations of Selection for Survival to Treatments with DDT and Benzene Hexachloride.**—*J. econ. Ent.* **46** no. 1 pp. 124–127, 2 graphs, 7 refs. Menasha, Wis., 1953.

Laboratory strains of the German cockroach [*Blattella germanica* (L.)] were reared through 12 generations of selection for resistance to treatment with DDT or γ BHC by dipping in suspensions. The criterion of selection in most cases was survival of treatments that gave more than 75 per cent. kill. In the 12th generation, males and females of the DDT strain were 22 and 198 times as resistant to DDT as those of an untreated strain on the basis of median lethal concentrations, and males and females of the BHC strain were 2·6 and 1·4 times as resistant to γ BHC. In the 11th generation,

females of the DDT strain were found to be 333 times as resistant to DDT as the untreated strain [*R.A.E.*, B **41** 104]; the difference is possibly attributable to a shorter period of immersion in the DDT suspensions in the tests with the 11th generation. Data obtained in the sixth–ninth generations showed that fewer nymphs per female were produced in the treated strains than in the untreated strain. The difference was highly significant in the DDT strain but was not significant in the BHC strain. Empty egg cases produced in the ninth generation by the treated strains were smaller in both length and width than those produced by the untreated strain. The differences were highly significant in the DDT strain and significant in the BHC strain. In the tenth generation, the weights of adult males and females of the DDT strain were less than those of males and females of the untreated strain, and the differences were highly significant, but there were no significant differences in weights between the BHC and untreated strains.

Roth (A. R.), Lindquist (A. W.) & Terriere (L. C.). **Effect of Temperature and the Activity of House Flies on their Absorption of DDT.**—*J. econ. Ent.* **46** no. 1 pp. 127–130, 5 refs. Menasha, Wis., 1953.

As DDT is more toxic to house-flies (*Musca domestica* L.) at 70 than at 90°F. [*R.A.E.*, B **34** 134; **38** 153], experiments with radioactive DDT were made to compare the amounts absorbed by the flies at these temperatures. Adults of a DDT-resistant strain treated individually with measured drops of the DDT in acetone solution and kept for 24 hours at 90°F., absorbed 64 per cent. more DDT than others similarly treated and kept at 70°F., though they suffered not much more than half the mortality. Studied in flies with low resistance, absorption of DDT began within an hour of application and gradually increased over several hours at both temperatures. Less DDT was absorbed at 70 than at 90° and knockdown began earlier. To determine whether increased physical activity at 90° was responsible for increased absorption of DDT, tests were made in which some flies were immobilised with carbon dioxide, and it was found that about the same amount of DDT was absorbed at a given temperature whether the flies were immobilised or active.

The excrement of treated flies showed some radioactivity. When fairly resistant flies were treated with 10 mmg. DDT, 0·08 mmg. was recovered from the excrement over a period of seven days. This was about 15 per cent. of the total absorbed as determined in other similarly treated flies. No radioactivity could be demonstrated in the carbon dioxide produced by DDT-treated flies.

Knutson (H.). **Susceptibility of a normal and an inbred Strain of *Drosophila melanogaster* to Dieldrin, Toxaphene, DDT, and Methoxychlor.**—*J. econ. Ent.* **46** no. 1 pp. 137–141, 1 graph, 18 refs. Menasha, Wis., 1953.

Drosophila melanogaster Mg. is being used as a test insect for the evaluation of insecticides and for studies of the genetic factors concerned in the development of resistance to them, but little is known of the effect of inbreeding on its susceptibility. In the tests described, males and females of a normal strain reared from wild flies from Rhode Island and a strain inbred by brother-sister matings for 12 generations were exposed to deposits of DDT, methoxy-DDT (methoxychlor), toxaphene and dieldrin from acetone solutions in glass vials for periods that would be expected to give

less than 100 per cent. kill, and subsequently observed for mortality. Each sex of the inbred strain was more susceptible to toxaphene, DDT and methoxychlor and less susceptible to dieldrin than the same sex of the normal one, and the relative susceptibility of the two sexes varied considerably in both strains, the differences between sexes being greatest for methoxy-DDT. Males were more susceptible than females in all tests except those in which the normal strain was exposed to toxaphene. There were also variations between strains and sexes in the times after exposure required for average maximum mortality and complete mortality, though the latter was seldom reached.

Potts (S. F.) & Spencer (R. A.). **Air-blast Spraying Apparatus for Helicopters.**—*J. econ. Ent.* **46** no. 1 pp. 147–150, 3 figs. Menasha, Wis., 1953.

Helicopters are more suitable than aeroplanes for spraying against insects that require heavy dosages and complete coverage for control, but their use has been restricted by high initial cost, low spray capacity (50–60 U.S. gals.) and the lack of a suitable apparatus for distributing a finely atomised spray. The normal boom attachment has nozzles that produce droplets 125–180 μ in diameter on an aeroplane travelling at 60–100 miles per hour, but of 200–300 μ on a helicopter, owing to the reduced wind action at the lower speed.

The authors describe an apparatus in which the air from the cooling fan of the helicopter engine is used to atomise the spray mixture; it provides much finer atomisation at delivery rates up to 12 U.S. gals. per minute with continuous agitation of the spray material in the tanks and permits the application of suspension sprays by the use of nozzles with a large orifice. It is light in weight and requires fewer nozzles, and spray drip is prevented by the continuous air blast and an instantaneous shut-off valve. It should give the best results when the optimum range of droplet diameters required is 40–60 μ. The air blast from the cooling fan is adequate to atomise sprays from small nozzles mounted on the rim of its outlet, but the exhaust gases are used to assist in producing the higher velocity needed for large nozzles. Severe flash tests showed that this procedure is safe for emulsion or suspension sprays and for oil solutions if the oil has a viscosity exceeding 44 secs. Saybolt. For inflammable mixtures of kerosene and xylene, only the air from the cooling fans should be used. The apparatus was employed successfully throughout a season in the United States against pests of forests and cranberry bogs, and also against mosquitos.

An arrangement is also described for applying dusts and sprays simultaneously from a helicopter by coating the dust with the spray liquid. Such a method of application is useful when two or more materials are not stable or compatible in the same spray mixture.

Dorman (S. C.) & Hall (W. E.). **An improved Spray Tunnel Method for Laboratory Tests.**—*J. econ. Ent.* **46** no. 1 pp. 151–153, 6 figs., 3 refs. Menasha, Wis., 1953.

The authors describe an apparatus for testing insecticides that was designed to incorporate in a simpler system some of the features of three already noticed [*cf. R.A.E.*, B **31** 210; **37** 201; **38** 148]. A horizontal wind tunnel six inches in diameter and 36 inches long has an air-brush type of spray nozzle at one end and leads into a fume hood at the other. The pressure from the spray nozzle is used to provide a constant velocity of air

in the tunnel, and the fume-hood door is left open, so that it merely carries away residual spray. The insects are exposed in cages placed just beyond the hood end of the tunnel. A copper-mesh cage is used for insects as small as Aphids or as large as cockroaches; it is fixed to a revolving axle so that all sides are sprayed uniformly. For house-flies [*Musca domestica* L.], however, disposable cages made of mailing tubes with net ends are employed, the tube being placed in a rotating cylinder.

In a series of comparative tests, lethal doses may be obtained by varying either the concentration of the spray or the volume discharged. The arrangement described is probably best adapted to discharging a constant small volume of 0·3–0·5 ml. and determining a median lethal concentration after a fixed time. If organic solvents are used, a small volume is desirable because of the possible toxicity of the solvent; comparisons of equal amounts of toxicant sprayed in different volumes of carrier showed little difference in mortality in most cases, indicating that this is primarily a function of the toxicant and not the carrier. A carrier of the kerosene type is preferred if the compound to be assayed is sufficiently soluble in it. For comparison, tests are made of the carrier alone and of a standard toxicant, such as parathion or DDT, which should preferably be of the same type as that being investigated. Tests with solvents differing in volatility showed that the weight of deposit decreased as the volatility of the solvent increased, but that the toxicity was little affected; this suggests that the finer droplets are more efficient, owing to the higher concentration of toxicant in them, or that the deposit of fine droplets round edges and fine appendages is a stabilising factor and contributes more to toxicity than is recognised. The use of the air-brush nozzle and the separation of large droplets by the horizontal tunnel resulted in droplets of which 98 per cent. had a diameter of between 0·25 and 4μ.

The results from the method corresponded satisfactorily with field practice, provided that the physical and chemical properties of the toxicants were adequately known and effectiveness was expressed as a function of another compound of known field usefulness. It has the advantages that a wide range of toxicity can be accurately and efficiently assayed, the results are not sensitive to operating variables, and insects and compounds of many kinds can be tested in the same machine.

Knipe (F. W.) & Frings (H.). **Oviposition by House Flies.**—*J. econ. Ent.* **46** no. 1 pp. 155–156. Menasha, Wis., 1953.

As the ovipositor of *Musca domestica* L. is very long in relation to the size of the fly, experiments were carried out to determine up to what distance females could reach breeding medium from which they were separated by wire screen. Tests in which dishes of medium held in place by screen were inverted at various distances above the screen top of the cage containing the flies showed that the latter could reach up to 12 mm. to place eggs with the ovipositor. The eggs were in well-formed clusters. Females also dropped eggs when stimulated by the presence of medium that they could not reach, such eggs being usually scattered.

Siverly (R. E.). **Natural Gas as a Blowfly Attractant.**—*J. econ. Ent.* **46** no. 1 p. 156, 2 refs. Menasha, Wis., 1953.

Three instances are briefly described of attraction of blowflies in Arizona to natural gas escaping from leaky supply pipes. In each case the smell of the escaping gas could be detected. Usually, dead flies were present as

well as living ones. Of 75 flies collected in one instance, 42 were *Lucilia* (*Phaenicia*) *sericata* (Mg.), 29 *Phormia regina* (Mg.) and four *Calliphora* (*Eucalliphora*) *lilaea* (Wlk.). All were females, and some had apparently died while ovipositing. The leaks also attracted species of *Callitroga* and *Sarcophaga*, but few if any Muscids were seen round them. The gas in the area contained traces of both butyl mercaptan (which had been added to it) and hydrogen sulphide. It is suggested that these compounds may be primarily responsible for attracting blowflies, which normally oviposit on meat or other products that liberate small amounts of hydrogen sulphide and volatile mercaptans during decomposition [*cf. R.A.E.*, B **33** 167; **40** 182, 183].

Sullivan (W. N.) & Hornstein (I.). **Chlorinated Polyphenyls to improve Lindane Residues.**—*J. econ. Ent.* **46** no. 1 pp. 158–159, 2 refs. Menasha, Wis., 1953.

As deposits of γ BHC as lindane are unsightly on some surfaces and generally dissipate by evaporation within a few weeks, the extent to which their appearance and persistence could be improved by blending the lindane with a chlorinated polyphenyl was investigated. Chlorinated polyphenyls are inexpensive, non-oxidising, of low volatility, non-corrosive to metals and resistant to fire and water, and they can be obtained as non-crystallising, film-forming materials of high molecular weight. Like lindane, they are chlorinated hydrocarbons, so that lindane would not be expected to crystallise out of the films, and mixtures of lindane with them have a lower vapour pressure than lindane alone, so that the deposits would presumably persist longer. The one selected as a result of preliminary tests was Arochlor 5460, an isomeric terphenyl (ortho, meta and para mixture) containing about 60 per cent. chlorine by weight. Carbon-tetrachloride solutions of lindane and Arochlor 5460 separately and together were tested on aluminium and masonite panels, which were kept in a horizontal position at 70–100°F. for three months. The deposit of lindane left after evaporation of the solvent was white, that of Arochlor 5460 was hard and transparent, and that of the mixture was clear, tenacious and slightly tacky. The toxicities of the deposits were tested after 2, 10, 30, 60 and 90 days by confining large nymphs and adults of *Periplaneta americana* (L.) on the panels for two hours under inverted petri dishes. After exposure, the cockroaches were kept under observation for 4 days. On an aluminium surface, lindane deposits of 50, 100 and 200 mg. per sq. ft. gave less than 40 per cent. kill after 10, 30 and 60 days, respectively, the periods over which the deposit was visible, whereas deposits containing 50, 100 or 200 mg. lindane with 200 mg. Arochlor 5460 per sq. ft. in each case gave 66, 80 and 99 per cent. kill after 90 days. The deposits remained transparent, tenacious and only slightly tacky. Except after two days, deposits on masonite were very much less toxic than those on aluminium and the mixtures differed little in effectiveness from lindane alone. Arochlor 5460 alone on aluminium caused no mortality.

Mitchener (A. V.). **Control of Mosquitoes with DDT, Aldrin, Dieldrin, Endrin and Isodrin.**—*J. econ. Ent.* **46** no. 1 p. 164. Menasha, Wis., 1953.

DDT has been used in mosquito control campaigns in Manitoba for the past five years, but though it kills larvae when sprayed on standing water and adults when applied as an aerosol with a fogging machine, it is not

entirely satisfactory because it is ineffective against pupae. Laboratory experiments were therefore undertaken in 1952 to compare the effectiveness of aldrin, isodrin, dieldrin and endrin * with that of DDT against larvae and pupae presumed to be those of *Aëdes dorsalis* (Mg.). The five insecticides were used at the rate of one part to one million parts water in the form of emulsifiable concentrates, and the percentages of larvae and pupae dead after 24 hours were recorded. These percentages were 15·2 and 2·4 for controls, 87 and 6 for DDT, 100 and 95 for endrin and 100 and 75–79 for the other three insecticides.

Love (G. J.) & Kartman (L.). **Effects on *Anopheles quadrimaculatus* of Dusting for Control of Cotton Insects.**—*J. econ. Ent.* **46** no. 1 pp. 166–167, 1 graph. Menasha, Wis., 1953.

Populations of *Anopheles quadrimaculatus* Say in Arkansas normally reach a peak in midsummer and decline with the onset of cold weather, but they were observed to be greatly reduced during periods in which insecticides were being applied for the control of cotton pests. A study of the effects of these applications was made in 1950. Cages of adults were put at various distances up to 500 yards away on the four sides of a 30-acre cotton field just before the application by a tractor-powered blower of a dust containing 3 per cent. BHC, 5 per cent. DDT and 40 per cent. sulphur between 8 and 11.30 p.m. The direction of the wind, which could be detected only by smoke, was north-east early in the evening and south-east after about 10 p.m. At 6.30 a.m. next day, all mosquitos were dead in cages up to 500 yards to the north, 415 yards to the east and 300 yards to the south, but there was only 14 per cent. mortality in the cage 500 yards to the south. The area to the west was heavily wooded, and the dust had no effect on adults in cages 100–200 yards away.

Few larvae of any mosquitos were found on weekly inspections of breeding-places during the period over which dust was being applied. Four light-traps were operated near the breeding areas each night throughout the summer, and many collections contained less than five mosquitos or even none during the dusting period. Most dusting was stopped at the end of August. Adults of *Psorophora* were collected in all traps after 6th–8th September and *Anopheles* counts increased after 9th–12th. Many males were among the first mosquitos collected. The intervals between the end of dusting and the appearance of the mosquitos in the traps corresponded closely with the duration of development of larvae in summer. The data suggest that mosquitos were trapped only after larvae not exposed to dusts had had time to develop and indicate that, except in densely wooded areas, dusting against cotton pests kills mosquitos within at least 500 yards. Probably no point in the rural areas of the region is further than this from a cotton field, and all fields were dusted by tractor equipment or aircraft.

---

* The names isodrin and endrin have been adopted by the U.S. Interdepartmental Committee on Pest Control [*cf. R.A.E.*, B **41** 1] subsequent to the publication of the definitions of aldrin and dieldrin already noticed [**41** 2]. Isodrin is defined by the Committee as 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-endo-endo-dimethanonaphthalene and endrin as 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-endo-dimethanonaphthalene, the names are applied to the pure chemicals, and it is stated that they are the endo-endo isomers of the compounds of which aldrin and dieldrin are, respectively, the endo-exo isomers. This statement would appear to restrict the application of the names aldrin and dieldrin to preparations comprising not less than 95 and 85 per cent., respectively, of the endo-exo isomers of the chemicals cited in their definitions instead of preparations containing similar proportions of any isomer or mixture of isomers of these chemicals.—*Ed.*

Farrar (M. D.) & Brannon (C. C.). **Fly Control on Dairy Farms.**—*J. econ. Ent.* **46** no. 1 p. 172. Menasha, Wis., 1953.

In view of the development of strains of *Musca domestica* L. resistant to DDT and other organic insecticides, fly control on dairy farms in the United States involves the use of a combination of measures including sanitation, screening and the use of traps and poison baits. A new poison bait that shows great promise is composed of 1·5–2·5 cc. TEPP (tetraethyl pyrophosphate), 4 fl. oz. molasses and 1 U.S. gal. water. It should be sprinkled on a clean wet or dry floor, and daily applications may be necessary if infestation is heavy. It kills all species of flies found on dairy farms and continues lethal to them for 4–5 hours. Great stress is laid on the precautions to be taken to avoid danger to the operator or contamination of milking equipment, feed or water, and to prevent people or animals from having access to the fresh bait, which is highly poisonous until it has been rendered harmless by exposure to air or water for some hours.

Frings (H.) & Frings (M.). **Dog Biscuit as a Larval Medium for *Sarcophaga bullata*.**—*J. econ. Ent.* **46** no. 1 p. 183, 2 refs. Menasha, Wis., 1953.

Sarcophaga bullata Parker has been successfully reared with moistened non-fermenting dog biscuit as the larval medium. The adults are kept in cages and supplied with water and sugar. Small pieces of meat are provided for larviposition, and the larvae are transferred, with or without the meat, to large jars half full of moistened dog biscuit and covered with fine screen. When the larvae are full-grown, a layer of sawdust or dry sand is added, in which they pupate and from which the pupae are easily separated. The success of the method, which had previously been in use in the authors' laboratory for rearing blowflies, depends on maintaining the right degree of moisture in the medium. House-flies [*Musca domestica* L.] have also been reared consistently for some years by a similar technique, but the females oviposit directly on the rearing medium, which is fermenting dog biscuit. More eggs were laid if the adults were provided with liquid milk than if they were given milk powder.

Barr (A. R.). **The Thermal Death Times of the aquatic Stages of some American dark-winged Anophelines.**—*Amer. J. Hyg.* **55** no. 2 pp. 170–181, 2 figs., 24 refs. Baltimore, Md., 1952.

In an attempt to find physiological differences more considerable than the morphological ones between *Anopheles quadrimaculatus* Say, *A. maculipennis freeborni* Aitken and *A. m. aztecus* Hffm., which the author treats as distinct species of the *maculipennis* group, the resistance of the larvae and pupae to heat was studied. The measurement used was the thermal death time or duration of exposure that caused 50 per cent. mortality at 42°C. [107·6°F.]. The pattern of change in thermal death time during development through the larval and pupal stages was similar for the three forms, but the extent of the change and the degree of resistance were different for each. *A. quadrimaculatus* was the most resistant and *A. m. aztecus* the least. The differences found were greater and more consistent than would be expected in races or possibly even subspecies on the basis of previous work on members of the group of *Culex pipiens* L. [*R.A.E.*, B **40** 67–86]. The differences between thermal death times of fourth-instar larvae and pupae were much greater in *freeborni* and *aztecus* than in *quadrimaculatus*, and this may indicate a closer relationship between the first

two. The earlier larval instars seemed to be more resistant to heat than the later ones, and within a given instar, young larvae were more resistant than older ones, but pupae were more resistant than their corresponding fourth-instar larvae. The change in resistance seems to be gradual.

Krieg (H.). **Erfahrungen bei der Anophelenbekämpfung in Oberitalien (Adriaraum).** [Experience in the Control of Anophelines in Upper Italy (Adriatic Region).]—*Anz. Schädlingsk.* **23** pt. 12 pp. 177–181, 4 figs. Berlin, 1950.

The author was in charge of the German mosquito-control service in the malarious districts between Venice and Lake Comacchio, on the Adriatic coast of Italy, during the German occupation in 1944. The area is low-lying and is richly watered by rivers, canals for irrigation and navigation, and saline lakes that are not themselves breeding sites for Anophelines, but lead to the formation of suitable sites in their vicinity. The vector of malaria is *Anopheles maculipennis* var. *sacharovi* Favr (*elutus* Edw.) [*cf. R.A.E.*, B **36** 61; **38** 214], which breeds in slightly saline water and was restricted to the malarious areas. Other races of *A. maculipennis* Mg., including *typicus*, *messeae* Flni. and *atroparvus* van Thiel, occurred in large numbers in both malarious and non-malarious areas. The incidence of malaria had greatly increased since the beginning of the war, and the disease was widespread among the inhabitants. The control measures adopted comprised treating houses and animal quarters with Gix [a preparation of fluoro-DDT] against the adult Anophelines, dusting suspected breeding places with a 1:100 mixture of paris green and road dust, and distributing the larvivorous fish, *Gambusia*. Both the insecticides gave very good results and troops were well protected from infection. The organisation of the local anti-malaria services and difficulties encountered in applying the measures described are discussed.

Mattingly (P. F.). **The Sub-genus *Stegomyia* (Diptera: Culicidae) in the Ethiopian Region. II. Distribution of Species confined to the East and South African Sub-region.**—*Bull. Brit. Mus. (nat. Hist.)* Ent. **3** no. 1 pp. 1–65, 15 maps, 3 pp. refs. London, 1953.

This second paper of a series [*cf. R.A.E.*, B **40** 153] is concerned with the distribution of the species of the subgenus *Stegomyia* of *Aëdes* that are restricted to the East and South African sub-region. As in the first paper, zoogeography is discussed mainly in relation to rainfall and altitude, and such notes on bionomics are included as are thought necessary for an understanding of distribution. *A. vinsoni*, sp. n., which is closely related to *A. aegypti* (L.) is described from Mauritius, and previously unpublished taxonomic data concerning most species are included. The distribution of pale forms of *A. aegypti* in the Ethiopian Region, additional records of the distribution of species treated in the first paper and corrigenda to the latter are given in appendices.

Haddow (A. J.), Dick (G. W. A.), Lumsden (W. H. R.) & Smithburn (K. C.). **Monkeys in Relation to the Epidemiology of Yellow Fever in Uganda.** —*Trans. R. Soc. trop. Med. Hyg.* **45** no. 2 pp. 189–224, 4 figs., 45 refs. London, 1951.

The following is taken from the authors' summary. The general rate of immunity from yellow fever found in protection tests on the sera of 1,069

monkeys of 16 kinds from areas extending over about half of Uganda was over 40 per cent. Immune monkeys were found in all the areas adequately sampled, except the Ruwenzori Mountain Forest, but the immunity rate varied considerably from district to district. Of the four species numerous enough for detailed study, the three that were mainly or exclusively arboreal showed no significant difference in immunity rates, but the rate in *Cercopithecus acthiops centralis*, which is largely terrestrial, was significantly lower than in the other three [*cf. R.A.E.*, B **41** 25, etc.]. When the entire sample was divided into three groups, the exclusively and the mainly arboreal groups showed no significant difference in the incidence of immunity, but the group of largely terrestrial monkeys had a significantly lower immunity rate than did the other two. From observations made in Bwamba County, it was found that there is no significant difference between the immunity rates in monkeys collected in the middle of a large uninhabited rain forest, round the forest edge and in the inhabited area adjoining the forest. The part played by monkeys in the epidemiology of yellow fever is discussed. On theoretical grounds, it is suggested that there may be a diurnal arboreal mosquito vector of the disease in monkeys in addition to the known nocturnal arboreal vector, *Aëdes africanus* (Theo.), and that it does not seem possible in certain areas that a continuous monkey-to-monkey transmission can be maintained [*cf.* **41** 24]. It is concluded that new infections must be introduced into such areas by wind-borne mosquitos coming from long distances or that there is an unknown Arthropod reservoir of the virus, perhaps associated with an unknown mammal cycle.

Hughes (M. H.) & Daly (P. F.). **Onchocerciasis in the southern Gold Coast.**—*Trans. R. Soc. trop. Med. Hyg.* **45** no. 2 pp. 243–252, 27 refs. London, 1951.

Previous reports on *Onchocerca volvulus* in man in the Gold Coast are reviewed, and an account is given of surveys made in July 1949 at two villages in a recently discovered focus of onchocercosis near the lower reaches of the River Volta. In the villages, 82 and 68·1 per cent., respectively, of the people examined showed evidence of onchocercosis. In the second, in which a fuller study was made, 56·6 per cent. of those with microfilariae of *O. volvulus* in the skin also showed microfilariae in the eyes. There was a blindness rate of 7 per cent. in the population. Ocular lesions were nearly three times as frequent in people with microfilariae in their eyes as in other onchocercal subjects whose eyes had escaped infestation.

The only known vector in the lower Volta is *Simulium damnosum* Theo., larvae and pupae of which can be found throughout the year in the rapids. The adults are most prevalent from June to November and hard to find during the dry, hot spring months. Of 20 collected at one place, four contained *Onchocerca*, one of them showing infective larvae in the head. Africans were bitten in preference to Europeans. The reported efficacy of dimethyl phthalate as a repellent [*R.A.E.*, B **39** 178; **41** 39] was confirmed. Other species of *Simulium* seen were *S. griseicolle* Becker, *S. unicornutum* Pomeroy and *S. impukane* De Meillon (*alcocki* var. *violaceum* Pomeroy), but none of these was found biting man. The Volta form of *S. griseicolle* differs in this respect from the typical Sudan form, as it does also in the shape of the pupal respiratory filaments, which are cylindrical rather than leaflike. The discovery of an endemic area of onchocercosis near the lower reaches of the Volta was of considerable importance in view of a proposal to erect a barrage across the river for the generation of electric power [**41** 28–29]. Workers on the project might be exposed to considerable danger in view of the high carrier rate amongst the local population

and the prevalence of the vector. However, the project offers the ultimate possibility of controlling *S. damnosum* by submerging the breeding places in the rapids above the dam, leaving a comparatively short stretch of river below the dam to be dealt with by other means.

WEYER (F.). **Die experimentelle Infektion der Filzlaus *Phthirus pubis* L. mit *Rickettsia prowazeki* und *R. quintana*.** [The experimental Infection of the Crab Louse with *R. prowazekii* and *R. quintana*.]—*Z. Tropenmed. u. Parasit.* **3** pt. 3 pp. 302–309, 5 figs., 15 refs. Stuttgart, 1952. (With a Summary in English.)

Experiments are described confirming that crab lice (*Phthirus pubis* (L.)) can be infected with *Rickettsia prowazekii* [*cf. R.A.E.*, B **37** 13] and showing that the rickettsiae increase in them. Concentrated suspensions of *R. prowazekii* or *R. quintana* from the stomach tissues of *Pediculus humanus humanus* L. were injected rectally into male and female crab lice, and the latter were subsequently caged on the human skin. *R. prowazekii* increased rapidly and was observed after 2–4 days in large numbers in short chain formations in smears and sections of the stomach and in the faeces of the crab lice, which soon succumbed to the infection. The rickettsiae developed intracellularly in the stomach epithelium. The experiments with *R. quintana* also gave positive results, but this rickettsia increased far less rapidly and remained extracellular. *P. h. humanus* was successfully infected rectally and mice intranasally with both rickettsiae in ground stomach tissue from infected crab lice. Both species of *Rickettsia* can thus maintain themselves and increase in crab lice, but the latter are not likely to be of importance in transmission since they remain too closely attached to a single host.

Further tests showed that the course of infection by the two rickettsiae in *P. h. capitis* Deg. was the same as in *P. h. humanus*.

PAPERS NOTICED BY TITLE ONLY.

DARSIE jr. (R. F.). **Pupae of the Culicine Mosquitoes of the northeastern United States (Diptera, Culicidae, Culicini).**—*Mem. Cornell agric. Exp. Sta.* no. 304, 67 pp., 91 figs., 3½ pp. refs. Ithaca, N.Y., 1951.

FOOTE (R. H.). **A Method of making whole Mounts of Mosquito Larvae for special Study.**—*J. Parasit.* **38** no. 5 pp. 494–495. Lancaster, Pa., 1952.

ROEDER (K. D.). Ed. **Insect Physiology.**—9¼ × 6 ins., [1 +] xiv + 1100 pp., 257 figs., 107½ pp. refs. New York, N.Y., J. Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1953. Price £6. [See *R.A.E.*, A **41** 285.]

ROSICKÝ (B.) & WEISER (J.). **Boj s hmyzem. Část I. Moderní insekticidy.** [Control of Insects. Part I. Modern Insecticides.]—438 pp., 100 figs., 38 pp. refs. Prague, Přírodověd. Vydavatelství, 1951. Price Kčs. 184. [See *R.A.E.*, A **41** 295.]

Houpeau (J.-L.) & Lhoste (J.). **Appareils français pour l'épandage d'insecticides sanitaires.**—230 [+ 11] pp., 36 pls., multigraph. Paris, Off. Rech. sci. Outre-Mer, 1953.

Descriptions are given of the characteristic features of more than 200 French machines and other apparatus used for applying insecticides against pests of medical and veterinary importance. These comprise dusters and sprayers, classified according to size, atomisers, bombs for discharging liquefied-gas aerosols, generators of thermal aerosols, flame-throwers, and fixed-wing aircraft and helicopters. A few articles of foreign manufacture are dealt with because of their special interest. A section on dipping (pp. 147–158) is also included; it is concerned with the planning of the necessary installations, the construction of the dipping vats, and the ways in which the animals are handled and treated.

Steiniger (F.). **Über eine Grossanwendung von Diäthylparanitrophenylmonothiophosphat (E 605 f) in der Wanzenbekämpfung.** [On the large-scale Application of Parathion (E 605 f) for the Control of Bed-bugs.]—*Z. Tropenmed. u. Parasit.* **2** pt. 4 pp. 544–558, 32 refs. Stuttgart, 1951. (With a Summary in English.)

Infestation of buildings by bed-bugs [*Cimex lectularius* L.] increased considerably in Schleswig-Holstein in 1945–47, and by the end of September 1950 36 million square feet of walls and ceilings had been sprayed with 0·05 per cent. E 605 f (an emulsion concentrate containing 74 per cent. parathion) by commercial operators. The author reports on his examination of about two-fifths of the total treated area. The liquid was applied at rates of approximately 1–2 pints per 100 sq. ft., and in droplets mainly of 40 μ or more in diameter, so as to avoid mist formation in the rooms. The floor was considered to be adequately covered by the spray that fell during treatment of the walls and ceiling. Furniture with which the occupants did not come into frequent contact was similarly treated, but clothing, beds, and other articles that were likely to come into contact with the human skin or with food were sometimes dusted with DDT. The bugs disappeared even when the DDT treatment was omitted. Although its initial effect was slow and living adult bugs were sometimes found after 12 days, parathion gave complete eradication in 80–90 per cent. of cases when applied once and in all cases when applied a second time after one month in summer or 2–3 months in winter. The success of the treatment was assessed in the following summer, when any survivors would have become noticeable. Reinfestation occurred in only one instance, 21 months after treatment.

The literature on the toxicity of parathion to man and other mammals is reviewed. Some operators at first complained of fatigue, which is not a known symptom of parathion poisoning, but no ill effects were reported after the autumn of 1948 or by the occupants of treated rooms, though some cases of poisoning are known to have occurred in other areas as a result of sleeping in rooms that had been treated with E 605 f at excessive concentrations. Protective masks are recommended for the operators but are rarely worn. It is concluded that no danger arises from the use of parathion by trained personnel, but, in view of the toxicity of E 605 f and similar concentrates, its legal recognition as a poison is recommended.

Longanecker (D. S.) & Burroughs (A. L.). **Sylvatic Plague Studies. IX. Studies of the Microclimate of the California Ground Squirrel Burrow and its Relation to seasonal Changes in the Flea Population.**—*Ecology* **33** no. 4 pp. 488–499, 9 figs., 10 refs. Lancaster, Pa., 1952.

The following is largely based on the authors' summary. Soil temperatures and the temperatures of an artificial burrow and of two natural burrows of

(1308) Wt. P9/3884 11/53 E.P. Ltd. Gp. 566. [B] A

Citellus beecheyi were studied in central California. The burrows are described. The depths of the artificial one, which was made of red tile drain pipes, were in the range of those of ground-squirrel nests dug out in the same area. Temperatures were recorded periodically for about 11 months with resistance thermometers and represent 48-hour averages of recordings made about every two hours. Shallow burrows showed the greatest daily and yearly variations in temperature. Minimum winter temperatures in the three burrows at depths of 13–60 ins. ranged from 44·5 to 53°F. and maximum summer temperatures from 67·5 to 77°F. Temperatures in a burrow measured at two-hour intervals for 48 hours varied little. The greatest variation, 6°F., occurred in late June at a depth of 20 ins. Temperature and relative humidity recordings were made in the entrances of several burrows in August and September. Temperatures in the entrances did not vary greatly from that of the outside air. During periods of decreased atmospheric humidity, relative humidities at a burrow entrance were about 10 per cent. higher than that of the outside air.

Seasonal variations in the temperatures of the burrows must affect the breeding of fleas, since the numbers of *Diamanus montanus* (Baker) on *C. beecheyi* trapped in the study area varied inversely with the burrow temperatures, whereas the numbers of *Hoplopsyllus anomalus* (Baker) varied directly. The former was predominant when the average burrow temperatures were below 60°F. at all depths and the latter when they were above 60°F. [*cf.* also *R.A.E.*, B **30** 34].

Crowell (R. L.) & Fay (R. W.). **Preliminary Experiments in the Use of hot DDT and other halogenated Hydrocarbons for residual Applications.** —*J. nat. Malar. Soc.* **10** no. 1 pp. 8–16, 2 figs., 9 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

It would be useful to supplement aerosol treatments for the control of insects in aircraft by the application of insecticide deposits, but the solvents used in solutions and emulsions harm various aircraft materials or cause risk of fire and the deposits left by suspensions and dusts are unsightly. The possibility of applying halogenated hydrocarbons as undiluted technical materials in a heated liquefied state was therefore investigated. In initial tests, DDT was liquefied in a beaker standing in a bath of boiling water and applied from a non-insulated pre-heated metal sprayer, in which it remained liquid for at least ten minutes at a room temperature of 70°F.; a pressure of 90–100 lb. per sq. in. was necessary for proper break-up and distribution of particles. DDD, fluoro-DDT (DFDT), methoxy-DDT (methoxychlor), heptachlor, chlordane, aldrin and γ BHC as lindane were applied in the same way, except that an oil bath was necessary to liquefy the last two, and all of them were about as effective as DDT, deposits of 200–400 mg. per sq. ft. on glass panels giving 97–100 per cent. mortality in 24 hours of females of *Musca domestica* L. exposed for 15 minutes. In subsequent experiments, DDT was applied at a pressure of 90–100 lb. from sprayers in which it was liquefied by thermostatically controlled heating elements.

Deposits of 200 mg. DDT per sq. ft. on glass panels, applied by the use of melted DDT, 5 per cent. DDT in emulsified xylene solution and 2·5 per cent. DDT wettable powder suspension gave complete kill for 12 weeks after application of females of *M. domestica* exposed for 30 minutes, but the same deposit from 5 per cent. DDT in emulsified xylene solution containing 2 per cent. resin did not remain toxic for more than four weeks. The type of deposit characteristic of each formulation and the effect on it of exposure to the flies are described. The effect of applications of 200 mg.

melted DDT per sq. ft. was tested on 31 samples of typical materials used in the interior of passenger aircraft. On the basis of 24-hour mortality of adults of *M. domestica* exposed for 15 minutes after two weeks, the deposits were effective on all surfaces examined except plastic-coated material and leather, on which they also left whitish specks. They left a barely noticeable whitish tinge on other surfaces. Deposits of 400–600 mg. melted DDT per sq. ft. caused no visible damage to Plexiglas or insulated electric wires over an inspection period of four weeks. Deposits of 200 mg. melted DDT per sq. ft. on sheet aluminium such as is used for luggage compartments, cupboards, etc., adhered very well when subjected to severe vibration and rubbing, whereas visible amounts of water-wettable DDT were removed from sheet aluminium under vibration and the deposits were almost entirely removed by a single rubbing stroke. It is concluded that melted DDT should be tried as an adjunct to aerosol applications in passenger aircraft, but that plastic-coated materials and leather should be left untreated. It is thought that insects knocked down by aerosols would fall on treated surfaces, insects alighting on treated surfaces would be stimulated to fly [*R.A.E.*, B **35** 108, etc.] and the effectiveness of subsequent aerosol treatments would thus be increased, and insects in parts of the aircraft not receiving aerosol treatments would be exposed to toxic deposits.

In view of the possibility that melted DDT might be of value for the control of insects outdoors, the experiment in which it was compared with emulsions and a suspension was repeated, but the treated panels were tested after being exposed to outdoor weathering for one, four, eight or 12 weeks. The melted DDT gave 100, 100, 75 and 3 per cent. kill after these periods, whereas the emulsion with resin gave 100 per cent. kill after all four, but the other formulations were much less lasting, the emulsion without resin giving 100, 99 and 6 per cent. kill after one, four and eight weeks and the suspension 100, 51 and 4 per cent. The difference in effectiveness of the emulsion containing resin was surprising, but microscopic examination of the deposits showed that much of the DDT was held in the resin droplets, and indoors was shielded from the insects by the resin. With outdoor weathering, the resin was gradually dissipated and left behind relatively fresh deposits of available DDT. The use of melted DDT against crop pests would eliminate risk of damage to plants by solvents or carriers and would effect a considerable saving of materials and reduction of equipment. Some preliminary studies indicated that it could also be used as an effective space spray.

Krusé (C. W.), Philen (E. A.) & Ludvik (G. F.). **Characteristics of larvicidal Sprays applied by Aircraft for the Control of** *Anopheles quadrimaculatus* **on impounded Water.**—*J. nat. Malar. Soc.* **10** no. 1 pp. 23–34, 3 graphs, 2 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

The following is mainly based on the authors' summary. An account is given of studies carried out in the Tennessee Valley on the penetration of high, dense, vegetative cover by DDT sprays applied from aircraft for the control of larvae of *Anopheles quadrimaculatus* Say. Efforts were made to determine the volumes and spray spectra needed to give satisfactory larvicidal doses on the breeding surface, and, if possible, the mechanism by which spray particles penetrate vegetation. All droplet data are presented in terms of the new constant D_0, determined by the graphical method previously described [*R.A.E.*, B **41** 55]. In most of the spray patterns in this series of tests, the value q [*loc. cit.*] was never greater than 0·5, while for thermal aerosols q values of 1 or 2 were quite common.

It was concluded that the best results would be obtained from sprays with a D_0 value of about 80 μ, and that great dependence must be placed on particles in the 1–50 μ diameter class. The volume of insecticide needed to produce sufficient particles was found to depend largely on the depth and, to a smaller degree, on the density, of the vegetation cover. Increased solvent density and solute concentration enhanced particle deposition, with a concomitant reduction in the numbers of particles needed to give adequate larval control. It was found that while a deposit of only 0·0007 lb. DDT per acre was needed to give a 90 per cent. lethal dose from applications of thermal aerosols, a deposit of 0·004 lb. DDT per acre was needed to produce the same mortality with nozzle-produced sprays. However, the larger deposits needed with the sprays were easier to obtain than were the smaller deposits needed with the aerosols.

Ludvik (G. F.), Snow (W. E.) & Hawkins (W. B.). **The Susceptibility of *Anopheles quadrimaculatus* to DDT after five Years of routine Treatment in the Tennessee River Valley.**—*J. nat. Malar. Soc.* **10** no. 1 pp. 35–43, 1 fig., 5 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

Comparative tests indicated that larvae of *Anopheles quadrimaculatus* Say from an area in the Tennessee Valley that had been treated with DDT larvicide for five years were less susceptible to DDT than those from an untreated area, but the differences were not statistically significant. Laboratory tests of adult populations of the same mosquito from an untreated area and from an area in which the buildings had been treated with DDT deposits for at least five years indicated a trend towards decreased susceptibility in the treated population, though the differences were significant in only one of these series of tests and were not great enough to be of practical importance. Further tests were made by releasing females of the two populations (differentiated by staining) in a room that had been treated with DDT at 200 mg. per sq. ft. When the release was made eight weeks after treatment, the percentages of the mosquitos that survived to enter a window trap and (in brackets) the percentages of these that were alive 72 hours later were 84 (24) in the females from the treated area and 45 (17) in the others. When the release was 11 weeks after treatment, the corresponding percentages were 81 (76) and 78 (60). Knockdown and mortality of the mosquitos that did not enter the trap were high and similar in the two populations. They were also similar when the mosquitos were released in the room 14 weeks after treatment and were prevented from escaping, but knockdown was considerably delayed. Females from both areas laid eggs on the sides of the cages in which they were kept after exposure.

Morning collections of mosquitos from equal numbers of DDT-treated and untreated portable resting stations situated in treated and untreated areas gave no indication of any significant resistance of *A. quadrimaculatus* in the treated zone, but they supported previous field tests [*R.A.E.*, B **34** 189] as to the irritating and repellent action of DDT deposits. In each area, only 1·9 per cent. of the mosquitos collected were in the treated stations, but these must have remained in them for at least 4–5 hours.

Davidson (G.). **Experiments on the Effect of residual Insecticides in Houses against *Anopheles gambiae* and *A. funestus*.**—*Bull. ent. Res.* **44** pt. 2 pp. 231–254, 1 pl., 2 graphs, 8 refs. London, 1953.

The experiments described were designed to confirm or disprove the conclusions reached by Thomson [*R.A.E.*, B **39** 187] on the behaviour

of *Anopheles gambiae* Giles and *A. funestus* Giles in huts treated with suspensions of proprietary wettable powders containing DDT or BHC (Ditreen and P 530, respectively) and to elaborate his observations by testing other formulations of these insecticides, including Supona (oil-bound) suspension concentrates [*cf.* **40** 111], and one of dieldrin. The work was done at Taveta, Kenya, between February 1950 and August 1951 in an isolated forest area associated with permanent spring water in an otherwise dry, open region. Experimental huts similar to the local dwellings and fitted with exit traps were used. Ditreen, which contains 37·7 per cent. DDT, did not completely fail to effect a kill in these experiments as it had done in Thomson's work, but 60 per cent. of the mosquitos escaped unharmed immediately after treatment and more afterwards, whereas no mosquitos survived adequate dosages of BHC or dieldrin, at least in the first month after treatment.

In preliminary experiments in which observations were carried on for nine months after treatment, P 530, which contains 44 per cent. BHC and was used at 20 mg. γ isomer per sq. ft., was still toxic after seven months, almost certainly because of the fumigant effect of the small amount of insecticide remaining below the wall surface. The two DDT formulations used, Ditreen at 98 mg. DDT per sq ft. and Supona-D (43·5 per cent. DDT) at 309 mg. DDT per sq. ft., still stimulated the mosquitos to flight after nine months. In the second group of experiments, dosages of less than 80 mg. DDT and less than 8 mg. γ BHC per sq. ft. gave over 50 per cent. kills of *A. gambiae* and *A. funestus* for only one month.

In a third group of experiments, the formulations used were two of BHC (P 520 containing 47·9 per cent. BHC in a wettable powder and Supona-B containing 49·2 per cent. BHC, applied at 21 and 18 mg. γ isomer per sq. ft.), five of DDT (two laboratory-made suspensions of DDT crystals measuring less than 30 and 30–70 μ and applied at 124 and 51 mg. DDT per sq. ft., respectively, Murphy paste and Murphy wettable powder containing 55·3 and 52·9 per cent. DDT and applied at 238 and 229 mg. DDT per sq. ft., and Supona-D, which was applied only to the roof at 187 mg. DDT per sq. ft.), Supona-DB (a mixture containing 13 per cent. BHC and 40 per cent. DDT) applied at an estimated rate of 7 mg. γ BHC and 223 mg. DDT per sq. ft. and a wettable powder containing 25·4 per cent. dieldrin and applied at an estimated rate of 50 mg. dieldrin per sq. ft. Dieldrin was by far the most effective insecticide and gave very high kills for nine months. The four DDT formulations applied to the whole internal surface of the huts produced fairly high kills (40–78 per cent.) over the same observation period, but considerable proportions of the mosquitos escaped their action even immediately after treatment. The BHC formulations gave high kills for 3–4 months only. The mixture of BHC and DDT gave the high initial kill of BHC (about 90 per cent. in the first two months) and the long-lasting moderately high kill of DDT.. The roof treatment with Supona-D gave only low kills (35 and 51 per cent. after one and two months, respectively). Little difference was noticed in the effects of the insecticides on the two species of *Anopheles*. *A. gambiae* was slightly the more susceptible to BHC in the fourth and sixth months after treatment, whereas *A. funestus* was slightly the more susceptible to DDT throughout the observations. All the DDT formulations used in the third group of experiments gave very low kills of females of *Culex pipiens fatigans* Wied., but BHC formulations gave high initial kills and dieldrin high kills throughout.

When mosquitos were exposed in cages hanging near a treated wall but not touching it, dieldrin caused very high kills for the six-month period of

the observations, DDT gave low kills, and BHC gave high kills for ten weeks but low kills after three months or more. It is probable that the action of dieldrin and DDT, which are not volatile, was due to the presence of airborne particles of insecticide in the hut, and that the kills effected by BHC were due to a combination of particulate and fumigant action.

It is likely that the differences in the effectiveness of the insecticides used are partly due to differences in irritant properties. Many mosquitos having contact with DDT were shown to be irritated and escape from the treated surface before they had acquired a lethal dose. Contact was longest with dieldrin. *A. funestus* remained in contact with treated surfaces rather longer than *A. gambiae*.

Hadaway (A. B.) & Barlow (F.). **Studies on aqueous Suspensions of Insecticides. Part IV. The Behaviour of Mosquitos in Contact with insecticidal Deposits.**—*Bull. ent. Res.* **44** pt. 2 pp. 255–271, 19 refs. London, 1953.

Work recorded in previous papers of this series [*R.A.E.*, B **40** 145, etc.] showed that the effectiveness of deposits from aqueous suspensions of DDT against *Aëdes aegypti* (L.) is influenced by particle size and by the type of material to which the deposits are applied, so that the use of different formulations on various building materials might partly explain conflicting results in Anopheline control [**39** 186–188]. The experiments described in this paper were therefore made to determine whether mosquitos (females of *Anopheles stephensi* List. unless otherwise stated) would pick up a lethal dose of DDT from the most effective formulations before they were stimulated to flight, to study the behaviour of mosquitos in contact with various compounds, and to determine whether there are any marked differences in the reactions of different species to insecticide deposits.

Mosquitos allowed to alight individually on deposits from aqueous suspensions took off again from all formulations of DDT on various materials (mud blocks, wallboard, unpainted wood and glass) after about 2–4 minutes, and subsequent kills were high only when the deposit consisted of particles of less than 10 μ and was readily available for pick-up (not adhering strongly, as it does on glass and deal wood). With *Aëdes aegypti*, which was also tested on fresh deposits on mud blocks, average contact time was no longer, but a kill of 73 per cent. was effected by particles measuring 10–20 μ. This may be because females of *A. aegypti* walk about, whereas those of *Anopheles stephensi* tend to remain stationary. Deposits of DDT two or four weeks old on mud blocks caused no mortality. Hardly any deposit was visible with the smallest particle size after two weeks and with any particle size after four weeks, and mosquitos remained in contact for 18 minutes or more.

Mosquitos were also stimulated to flight by contact with fresh deposits of a BHC wettable powder, but all died very quickly. When contact was prevented, mosquitos were not disturbed by the vapour from BHC deposits until poisoning had reached an advanced stage. The time to the first flight from surfaces treated with BHC wettable powder increased as the deposits aged and varied on different types of surfaces according to the rate of loss by evaporation, sorption or both. Mosquitos were not activated by contact with deposits (100 mg. per sq. ft.) of α-chlordane, technical chlordane, dieldrin, aldrin, compound 269 [endrin], compound 711 [isodrin] or toxaphene, and, in individual exposures, all these insecticides gave 100 per cent. kill except toxaphene, which gave none. The mean time to first flight in minutes was shortest (25) for technical chlordane and longest (over 60) for α-chlordane, indicating that the latter is one of the less biologically

active constituents of the former. Experiments with a number of DDT analogues and BHC isomers indicated that lipoid solubility and molecular structure are two factors governing the rate of penetration of a compound. Substitution of other halogens for chlorine in the p,p′ positions of the DDT molecule produced marked changes in the rate at which mosquitos responded to contact with the deposits, irritation being greatest for fluoro-DDT, less for bromo-DDT than for DDT, and negligible or absent for iodo-DDT. The mosquitos used to compare the reactions of different species were females of *A. stephensi*, *A. gambiae* Giles, *A. quadrimaculatus* Say and a London strain of *Culex pipiens molestus* Forsk., and they were exposed to deposits of DDT, BHC and dieldrin from wettable-powder suspensions. There was no marked difference in the times in which the different species were activated by contact with a given insecticide, and contact with BHC or dieldrin caused 100 per cent. mortality of all four, but no mortality of *C. p. molestus* was caused by a single contact with the DDT deposits, although they consisted of particles of less than 10 μ and killed 53–70 per cent. of the three Anophelines.

Edney (E. B.). **The Construction and Calibration of an electrical Hygrometer suitable for microclimatic Measurements.**—*Bull. ent. Res.* **44** pt. 2 pp. 333–342, 5 figs., 6 refs. London, 1953.

The electrolytic hygrometer described is based on the principle of the Gregory hygrometer, but the element is considerably smaller (about 6 × 6 × 10 mm.). The element consists of two platinum-clad nickel-iron electrodes round which is wound a spiral of continuous fibre-glass wool yarn impregnated with a solution of calcium chloride. The water content of this salt, and consequently the resistance between the electrodes, varies with relative humidity, and this resistance is measured by micro-ampere records of alternating current of a known voltage. The resistance also varies with temperature and calibration must be carried out at different constant temperatures covering the range at which the instrument is used. The temperature of the element is measured by a fine thermocouple permanently attached to it. An element impregnated with 1 per cent. calcium chloride gives readings correct to within 2 per cent. for relative humidities of 50–98 per cent., and one impregnated with 5 per cent. calcium chloride is satisfactory for humidities of 10–60 per cent.

Details are given of the design of the hygrometer element and a suitable wiring circuit and of apparatus and methods for calibrating it in the laboratory and recalibrating it in the field. An ageing process is necessary before calibration, and recalibration is required at about fortnightly intervals during constant use. The advantages of instruments of this type for microclimatic work are that they are small, can be read at a distance, and do not depend upon evaporation of water, so that disturbance of the natural environment is minimised. The main disadvantages are that they cannot be exposed to saturated air without going out of calibration and that each instrument must be calibrated individually, so that they cannot easily be standardised for mass production.

Kitchen (W. H.) & Gall (D.). **A controlled Humidifier for Insect Breeding Rooms.**—*Bull. ent. Res.* **44** pt. 2 pp. 367–369, 1 fig., 1 ref. London, 1953.

In climates with a dry but relatively cool season, it is possible to keep the humidity in insect-breeding rooms at a required level by drawing air

over a wet screen, but as a result the temperature of the room may fall below that necessary for the insects. In order to overcome this difficulty in a room in which tsetse flies [*Glossina*] were being reared, a humidifier consisting of a simple atomiser with a controlling hygrostat was devised and is here described. Air was blown through one of two nozzles apposed at right angles, the other being connected to a water reservoir, using a compressor motor controlled by a hair hygrostat operating a hotwire vacuum switch. This effectively introduced a large volume of water into the air as a fine mist with negligible cooling.

Busvine (J. R.) & Nash (R.). **The Potency and Persistence of some new synthetic Insecticides.**—*Bull. ent. Res.* **44** pt. 2 pp. 371–376, 1 fig., 5 refs. London, 1953.

Simple laboratory procedures used for assessing the initial potency and persistence of insecticides against various arthropods are described. Exposure was on filter papers impregnated with a constant volume of solution by a method essentially the same as that used by Busvine & Barnes [*R.A.E.*, B **35** 147], but mineral oil was substituted for a more volatile solvent in tests of initial potency, because evaporation of the latter leads to irregular size and distribution of crystals, with consequent erratic results. As the test insects would tend to be contaminated with the oil to the same extent, the lethal effect would be directly related to insecticide concentration. Crawling insects were confined under inverted glass funnels and mosquitos in cylinders of the filter paper with glass ends, but glass rings (instead of funnels) and cylinders closed with netting were used in tests with γ BHC to minimise its fumigant effect.

The median lethal concentrations in the oil solutions of nine insecticides to adults of *Cimex lectularius* L. and a London strain of *Pediculus humanus humanus* L. [*cf.* **41** 159] adult females of *Aëdes aegypti* (L.), fourth- and fifth-stage nymphs of *Rhodnius prolixus* Stål, and first-stage nymphs of *Ornithodoros moubata* (Murr.) are shown, together with those for adults of *Xenopsylla cheopis* (Roths.) quoted from the work of Shawarby [see next abstract] and those for adults of *Musca domestica* L. obtained by a different method. The exposure periods were 24 hours for *Cimex*, *Rhodnius* and *Ornithodoros*, 18 hours for *Pediculus* and 1 hour for *Xenopsylla* and *Aëdes*. The order of effectiveness of the insecticides differed to some extent according to the species exposed to them, but either γ BHC or dieldrin was the most toxic to all, and the approximate order of potency was γ BHC>dieldrin >aldrin = pyrethrins>chlordane = DDT = 1-phenyl-3-methyl-pyrazolyl-(5)-dimethyl carbamate (Pyrolan [*cf.* **41** 69]) = allethrin>toxaphene. Lasting action was judged by the mortality of batches of *C. lectularius* exposed to dry films of the insecticides from acetone solutions at intervals up to six months after preparation. The approximate order of persistence was dieldrin = DDT = toxaphene>Pyrolan>γ BHC = chlordane = aldrin>allethrin>pyrethrins. This probably gives a fair impression of the relative persistence of these insecticides indoors in England. Dieldrin is one of the most promising of the insecticides, being both highly effective and persistent. In dry films, Pyrolan was about three times as rapid in its knockdown action on *M. domestica* as DDT, but rather more of the paralysed flies recovered. Pyrolan was quite as toxic to two DDT-resistant strains of *M. domestica* as to normally susceptible ones.

Shawarby (A. A.). **Laboratory and Field Trials in the Control of Fleas and Lice.**—*Bull. ent. Res.* **44** pt. 2 pp. 377–385, 4 graphs, 17 refs. London, 1953.

The median lethal concentrations of some persistent insecticides for adults of *Xenopsylla cheopis* (Roths.) were measured by applying oil solutions to filter paper at 3 mg. solution per sq. cm. and compared with those for *Pediculus humanus humanus* L. (*P. h. corporis* Deg.) as determined by Busvine & Nash [see preceding abstract]. The order of toxicity of the insecticides to the fleas and (in brackets) the median lethal concentrations expressed as percentages in the oil were γ BHC (0·018), dieldrin (0·032), aldrin (0·048), chlordane (0·33), DDT (0·37), pyrethrins (0·5), toxaphene (2) and allethrin (2·5). The order and concentrations for the lice were dieldrin (0·015), γ BHC (0·025), aldrin (0·038), chlordane (0·11), pyrethrins (0·14), allethrin (0·59) and DDT and toxaphene (both 0·6). In a test of wettable-powder suspensions on mud blocks of London soil, however, γ BHC was only three times as toxic to *X. cheopis* as DDT. The γ BHC was 36 times as toxic as p,p′ DDT to flea larvae when tested in oil solution. Emergence of adults from pupae was completely prevented by spraying the pupae with 0·5 per cent. wettable suspensions of either insecticide or by exposing them on sand mixed with 2 per cent. by weight of dusts containing 10 per cent. DDT or 0·5 per cent. γ BHC.

Field trials of DDT and BHC against *P. h. humanus* and *Pulex irritans* L. were carried out in Egypt in 1950; the DDT used contained 70 per cent. p,p′ isomer. In the experiment against *P. irritans*, all floors and the contiguous 2 ft. of wall surface of mud-brick houses were sprayed with wettable-powder suspensions to give deposits of 2 gm. DDT or 143 mg. γ BHC per sq. metre. The BHC gave much better control over the period of the experiment (24 weeks), and the degrees of control initially achieved (94 and 55 per cent. reduction in numbers of houses infested) were maintained for 8 weeks with BHC and 12 weeks with DDT. Dusts containing 10 per cent. DDT or 0·4 per cent. γ BHC were used in the experiment against *Pediculus* and the clothes were dusted on their wearers with 40 mg. dust per person. The BHC was again more effective than the DDT; it caused immediate reductions of 97 per cent. in the proportion of persons infested and 99·5 per cent. in the number of lice per person (as compared with 73 and 75 per cent. for DDT), and the low levels were more or less maintained for several weeks. Resistance to DDT in *Pediculus* has recently been demonstrated in Korea [**41** 106] and by Busvine in an Egyptian strain [*R.A.E.*, B **41** 159]. It was found possible to develop slight resistance in *X. cheopis* by selection in the laboratory. Resistance to DDT may be a factor contributing to the relatively greater efficiency of BHC.

Oppenoorth (F. J.) & Dresden (D.). **Selection of a BHC-resistant Strain of *Drosophila melanogaster* Mg.**—*Bull. ent. Res.* **44** pt. 2 pp. 395–400, 3 graphs, 8 refs. London, 1953.

The experiments described were carried out by methods already noticed [*R.A.E.*, B **41** 37–38], and two strains of *Drosophila melanogaster* Mg. reared from wild flies and a Berlin inbred strain were used in the first series. Successive generations were reared from adults that had survived exposure to deposits of γ BHC that gave 60–80 per cent. mortality, and resistance appeared in all three strains to about the same extent and after about the same number of generations, although their original susceptibilities were different. It thus appeared that differences in homogeneity of the original material had no influence on the final result of selection and all subsequent tests were made on one of the strains (W1) from wild flies.

Resistance in W1 was produced in 13 selections and was not much greater after 24, when the median lethal deposit in mmg. per 90 sq. cm. was 6·9 as compared with 1·6 for unselected W1. Adults of the 24th selection also showed resistance to γ BHC applied topically or by injection and to kill by DDT and knockdown by Thanite. F_1 flies from the reciprocal crosses between W1 and resistant W1 resembled one another in susceptibility to contact with γ BHC, and resembled the resistant strain rather than the susceptible one. It thus appeared that resistance does not depend on cytoplasmic heredity and that it is incompletely dominant.

The fact that resistance developed to the same degree in the three strains appeared to exclude the possibility of its being due to mutation and suggested that it resulted from a change in the frequency of one or more of the genes present.

Bartlett (B. R.). **A Study of Insecticide Resistance in Strains of *Drosophila melanogaster* Meig.**—*Canad. Ent.* **84** no. 7 pp. 189–205, 3 figs., 24 refs. Ottawa, 1952.

The following is virtually the author's summary. Sixteen strains of *Drosophila melanogaster* Mg. representative of diversified climate and food habits were assembled from laboratory and field sources. These strains were isolated as family lines and tested for extent of susceptibility to DDT (a contact poison), tartar emetic (a stomach poison) and hydrocyanic acid gas (a respiratory poison). Suitable test methods for adequate evaluation of small differences in susceptibility between the strains were developed. Differences between strains in resistance to all three poisons were demonstrated. Resistance was shown to be inherited and not associated with nutrition. Successive selective insecticidal treatments resulted in increased resistance in some strains, but not in others. The rate of increase in resistance to DDT and HCN was very slow. Evidence of more than one level of DDT-resistance in relatively isogenic strains suggests that this resistance develops in steps. Resistance to DDT and HCN was tested with adults only. Resistance to tartar emetic was demonstrated in both adults and larvae but was more pronounced in the larvae. Several strains were markedly resistant to tartar emetic. This resistance was not specific for tartar emetic, but extended in some degree to DDT and to HCN.

Resistance by the strain most highly resistant to HCN was shown to have some specificity for HCN, since the strain was not resistant to DDT or tartar emetic. Adults of this strain were shown, however, to be resistant to diethyl ether and to a subfreezing temperature (10°F), as well as to anaesthesia induced from either of these two treatments. Inheritance of resistance to HCN was indicated as being without sex-linkage.

The strain of *D. melanogaster* showing greatest resistance to DDT was also highly resistant to fluoro-DDT, moderately resistant to HCN and tartar emetic, and slightly if at all resistant to Thanite (isobornyl thiocyanoacetate).

Busvine (J. R.). **Forms of Insecticide-resistance in Houseflies and Body Lice.**—*Nature* **171** no. 4342 pp. 118–119, 4 refs. London, 1953.

Starting with insecticide-resistant strains of house-flies [*Musca domestica* L.] from Italy (*I*) and Sardinia (*S*) [*R.A.E.*, B **41** 122] and a non-resistant colony from Rome (*N*), the author attempted the segregation of strains with different kinds of resistance by selective breeding. When the *N* and *S* strains were crossed and the male progeny that survived exposure

to γ BHC were back-crossed with susceptible females for three generations, resistance to γ BHC was maintained and some tolerance of chlordane and dieldrin was preserved, while resistance to DDT was lowered practically to normal. Resistance to chlordane, dieldrin and γ BHC rose 500, 300 and 60 times, respectively, in a line (*Ch*) derived from the *I* strain by selection for resistance to chlordane on six occasions over a period of 11 generations, whereas resistance to DDT increased only 2·2 times. Selection by exposing batches of flies of a sub-colony (*P*) of the *I* strain to pyrethrins seven times in 12 generations caused only a slight increase in resistance. Flies of this sub-colony were subsequently twice selected for resistance to paralysis by DDT, and resistance to pyrethrins increased somewhat in consequence. An *SS* sub-colony was derived from the *S* strain by selecting for resistance to kill by DDT in two successive generations to make the average lethal dose about the same as that for the *Ch* sub-colony, and an *S k-d* sub-colony was selected for resistance to DDT-paralysis over 11 generations by breeding from flies not readily knocked down by DDT. These various strains were then maintained in isolation without further treatment, and tests were made of their insecticide resistance. In addition to those used in the preceding tests, the insecticides included DANP (1,1-dianisyl-neopentane), which is a DDT analogue of interest in connection with the mechanism of resistance to DDT because all the chlorine atoms of the latter are replaced by methyl or methoxy groups [1,1-di(p-methoxyphenyl)-2,2,2-trimethyl-ethane]. The median lethal concentrations (MLC) of all the insecticides to each strain and also the rates of knockdown by DDT are given in a table, and the following conclusions are drawn from it. Resistance to BHC and chlordane are independent of resistance to DDT, but the factors for resistance to BHC, chlordane and dieldrin are linked, so that selection with one raises resistance to the others. Resistance to paralysis caused by DDT is not closely linked with resistance to its lethal effect [*loc. cit.*]. Strains *I* and *S* have about the same resistance to the lethal action of DDT and so have strains *Ch* and *SS*, but the first member of each pair is considerably more resistant to paralysis than the second. Resistance to DANP is correlated with resistance to pyrethrins and to paralysis by DDT. This is an extension of an earlier observation that resistance to DDT analogues in the *I* strain (which is resistant to pyrethrins and to paralysis by DDT) is, unlike that in the *S* strain, unrelated to the ease of dehydrochlorination. It seems that there is a DDT-resistance factor not concerned with dehydrochlorination [*cf. loc. cit.*] and associated with resistance to paralysis by DDT and kill by pyrethrins.

Reports having been received of resistance to DDT in body lice [*Pediculus humanus humanus* L.] in Korea [*cf.* **41** 106], a strain of body lice was reared from eggs obtained from a laboratory colony in Cairo for experiments on alternative insecticides. Spray tests, however, indicated that the MLC of DDT for the Egyptian strain was nine times as great as that for susceptible British lice assessed by the same technique in 1946 [**36** 217], the MLC of γ BHC being 1·3 times as great. Tests in which lice of the Egyptian strain and a new susceptible strain from London were exposed in batches for 18 hours at 30°C. [86°F.] on filter papers impregnated with insecticides in a constant volume of oil [*cf.* **41** 156] indicated that the Egyptian lice were about normally susceptible to γ BHC, chlordane, dieldrin, aldrin, toxaphene, allethrin and pyrethrins, whereas the MLC of DDT for them was much more than 3 per cent. as compared with 0·6 per cent. for the London strain. As the MLC of DANP for the London strain was 2·5 per cent., whereas none of the Egyptian lice was killed by 10 per cent., the DDT resistance of the latter cannot be accounted for by a dehydrochlorination mechanism. It may have resulted from large-scale dusting

of Egyptian villagers with DDT for four years before the Cairo colony was started. The colony had been kept for two years without exposure to insecticide before the eggs from it were sent to London. The Egyptian lice appear to be less resistant to DDT than the Korean ones.

DAVEY (J. T.) & O'ROURKE (F. J.). **Observations on *Chrysops silacea* and *C. dimidiata* at Benin, Southern Nigeria. Part III.**—*Ann. trop. Med. Parasit.* **45** no. 2 pp. 101–109, 1 graph, 9 refs. Liverpool, 1951.

In this third paper of a series on *Chrysops silacea* Aust. and *C. dimidiata* Wulp at Benin [*cf. R.A.E.*, B **41** 28], data are given on the habits of the immature stages and the factors that limit their distribution in the breeding areas. From 1947 onwards, larvae were collected by washing riverside mud through a series of sieves of increasing fineness. Of 653 Tabanid larvae collected for breeding in 1946–50, only 68 gave rise to adults. These included 11 of *C. silacea*, 7 of *C. dimidiata* and 22 of *C. longicornis* Macq. The reasons for the high mortality are not known. At first, small insects or chopped earthworms were provided as food, but though this was necessary for other Tabanids, the larvae of *Chrysops* were never seen to feed on them. It is thought that *Chrysops* larvae are probably saprophagous, feeding on the organic matter in the mud. Breeding was confined to certain reaches of the river where the banks were swampy and the mud was covered by a thick mass of decaying vegetation, and there was generally dense shade [*cf.* **40** 10]. Within such sites, the larvae appeared to be restricted to well-defined microhabitats. Like other Tabanid larvae, they were found in saturated and damp mud and occasionally in mud under about an inch of water but not in dry mud or mud under deep water. The pH of the mud ranged from 4·3 to 5·2, and distribution appeared to be independent of pH within this range. The mud was sampled to a depth of 12 ins., and larvae were found only in the top 3 ins. The carbon-nitrogen ratio of the mud was usually about 17 : 1. In the five years, only 11 Tabanid pupae were found; six proved to be *C. longicornis*.

The average length of larval life after collection was about 27 days for *C. dimidiata* and 15 for *C. silacea*, but as very few young larvae were recovered and breeding in captivity was not accomplished, the full length of larval life was not determined. It seems likely that most of the eggs laid early in the fly season [**41** 28] at Benin give rise to adults before the end of the season. Very few larvae were taken late in the season, and none of them gave rise to adults in the laboratory. On one occasion, two larvae of *C. dimidiata*, which were fully grown when captured in August, spent 43 days as larvae. It is possible that they were taken during a resting stage. The existence of such a stage during the dry season in West Africa seems likely, but the date of collection was earlier than the onset might be expected. It is possible that a resting stage, if it occurs, takes place at a greater depth than 12 ins. The pupal stage lasted only about 8 or 9 days in the laboratory.

It is thought that at Benin, insecticidal control would be practicable against the larvae only, as the adults are too widely distributed. It would necessitate a close investigation of the precise conditions determining the local distribution of the larvae in the mud throughout the year, and of the flight-range of the adults. The possibility of control by altering the water content of the mud by drainage, exposure to sun or flooding is suggested. Screening gives limited protection against the adults, and dimethyl phthalate undiluted or in 60 per cent. strength gave protection in the open for at least 2–3 hours.

Gillett (J. D.). **The Habits of the Mosquito *Aëdes (Stegomyia) simpsoni* Theobald in Relation to the Epidemiology of Yellow Fever in Uganda.** —*Ann. trop. Med. Parasit.* **45** no. 2 pp. 110–121, 15 refs. Liverpool, 1951.

The following is mainly based on the author's summary. Investigations in Bwamba, western Uganda, have shown that the requirements for the occurrence of yellow fever in man are the presence of *Aëdes simpsoni* (Theo.) in plantations in close proximity to forest containing monkeys and the arboreal mosquito *A. africanus* (Theo.) [*R.A.E.*, B **40** 2]. These requirements are met in many parts of Uganda, and immune monkeys have been found in practically all the areas adequately sampled [**41** 147], yet yellow fever in man appears from the human immunity-rate to be negligible in most parts of the country. It is suggested that this may be explained by the failure of *A. simpsoni* to bite man in such areas, whereas it does so readily in Bwamba. The theory was tested by making a series of catches for a total of 406 hours in plantations in places outside Bwamba. *A. simpsoni* was not represented among the 5,291 mosquitos taken, although there was a relatively large concentration of the plants it habitually breeds in [**31** 182] and its larvae and pupae were present in all the plantations chosen. Most catches lasted throughout the 24 hours. On the other hand, in 46·5 hours of catching in plantations in Bwamba, 30 adults of *A. simpsoni* were taken biting man out of a total of 94 mosquitos. Five out of eight laboratory-bred females of *A. simpsoni* from the Entebbe area fed when offered a blood-meal on the author. Morphological studies of Bwamba and Entebbe material failed to reveal any structural differences in larvae, pupae or adults. It is believed that the difference in biting behaviour observed in the field may have some association with the population density of the species (as indicated by the percentage of suitable breeding-places occupied by the aquatic stages), but that it cannot be explained by density alone. The inhabited part of Bwamba varies in altitude from about 2,200 to about 3,500 ft. and is lower than any of the other catching places chosen for this work. No adults of *A. simpsoni* were taken at altitudes above 3,800 feet, although larvae and pupae were present there. It is thought that the difference observed in biting behaviour may be associated in some way with altitude, possibly through temperature. It is further suggested that the scattered human immunes that occur in the areas where *A. simpsoni* has not been found to attack man may be accounted for by occasional visits of *A. africanus* from neighbouring forest. Some speculations as to the origin of domesticity in *A. simpsoni* are discussed.

Marks (E. N.). **The Vector of Filariasis in Polynesia: a Change in Nomenclature.**—*Ann. trop. Med. Parasit.* **45** no. 2 pp. 137–140, 16 refs. Liverpool, 1951.

Examination of adults of *Aëdes pseudoscutellaris* (Theo.) reared from material received from Fiji and of the type material showed that they differed constantly in scutal scaling and male genitalia from the widely distributed Polynesian mosquito that has long been considered to be this species, and the latter is named *A. polynesiensis*, sp.n. Fiji is the type locality of both. The larvae differ in that the difference in length between the lower and upper gills is greater in *A. polynesiensis*. Examination of specimens from almost all the islands from which the mosquito identified as *A. pseudoscutellaris* has been recorded [*cf. R.A.E.*, B **34** 37] indicates that *A. polynesiensis* occurs in Fiji, Samoa and the Ellice, Cook, Society,

Austral, Mangareva, Tuamotu and Marquesas Islands and that *A. pseudoscutellaris* is confined to Fiji. It is evident that *A. polynesiensis* is the species known to transmit filariasis [*Wuchereria bancrofti*] and that the rôle of *A. pseudoscutellaris* as a vector is yet to be established.

WHARTON (R. H.). **The Habits of Adult Mosquitoes in Malaya. I. Observations on Anophelines in Window-trap Huts and at Cattle-sheds.**—*Ann. trop. Med. Parasit.* **45** no. 2 pp. 141–154, 1 map, 17 refs. Liverpool, 1951. **II. Observations on Culicines in Window-trap Huts and at Cattle-sheds.**—*T.c.* pp. 155–160, 11 refs.

These two papers initiate a proposed series on observations on the habits of adult mosquitos in Malaya made in the course of tests on the effectiveness of deposit insecticides against *Anopheles maculatus* Theo. [*cf. R.A.E.*, B **39** 186], the only vector of malaria in the area chosen. Earlier observations in Malaya are briefly reviewed. The following is almost entirely taken from the author's summaries of the two papers.

The habits of several species of *Anopheles*, including *A. maculatus*, were observed in experimental huts fitted with window exit-traps, at cattle-sheds (where they were collected from surrounding grass), and in a man-baited net trap. *A. philippinensis* Ludl. was the dominant Anopheline in the area and at cattle-sheds, in the net trap and a calf-baited hut. *A. maculatus*, *A. hyrcanus* (Pall.), *A. vagus* Dön., and *A. aconitus* Dön. were also common, and there were small numbers of *A. barbirostris* Wulp, *A. karwari* (James), *A. kochi* Dön. and *A. tessellatus* Theo. All were found at cattle-sheds. All the common species attacked man in the open at night and entered the net trap, but only *A. maculatus* attacked man readily inside rooms, and even this species, although prepared to enter dwellings, preferred to feed in the open. It was the only species found to enter man-baited huts regularly, but several species, including *A. maculatus*, *A. philippinensis*, *A. hyrcanus*, *A. vagus* and occasionally *A. aconitus*, entered calf-baited huts. Goats and dogs in the huts were less attractive than calves. One calf attracted about the same number of *A. maculatus* as two men; two dogs attracted more and two goats slightly fewer. Two men attracted more *A. maculatus* into a hut than one man, but in these experiments one of the men was found to be relatively unattractive to *A. maculatus*, though he was as attractive as the other men to *Culex pipiens fatigans* Wied.

It was found that the large majority of all Anophelines left the huts before 8 a.m. [*cf.* **39** 187], and that *A. vagus* was the only species that showed any tendency to remain in the huts by day. About 50 per cent. of all *A. maculatus*, *A. philippinensis* and *A. hyrcanus* caught in the exit-trap had entered it by midnight, and 80–90 per cent. by 5 a.m. (an hour before dawn). A large proportion of *A. maculatus*, *A. philippinensis* and *A. hyrcanus* entering the huts did so after 9 p.m., but very few *A. vagus* entered after 8 p.m. Catches around the cattle-sheds showed that Anophelines, fed and unfed, rested on grass-stems from dusk to dawn, with little variation in the proportions of the various species present at different times. Catches of Anophelines biting cattle showed that most species attacked at all hours of the night, but that *A. vagus* and *A. hyrcanus* fed mainly between 7 and 8 p.m., whereas *A. philippinensis* did not begin biting in large numbers until after 9 p.m.

The biting habits of several species of Culicini were also observed in the experimental huts and at cattle-sheds. Females of *Culex pipiens fatigans*, the only truly domestic species regularly seen in Malaya, entered man-baited

huts and fed in large numbers. Fewer entered huts baited with calf or goat, and very few indeed fed. Small numbers of *C. vishnui* Theo., *C. gelidus* Theo., *C. sinensis* Theo. and *Mansonia uniformis* (Theo.) fed on man. A calf was much more attractive to them. Goats and dogs attracted a few of the three species of *Culex* but did not attract *M. uniformis*. Few mosquitos except *C. p. fatigans* remained in the huts after feeding. Most left before midnight. Most of the common species, including *M. uniformis* but excluding *C. p. fatigans*, attacked man in larger numbers in the open than in a room. *C. gelidus* and *M. uniformis*, and to a smaller degree *C. vishnui*, were attracted to their blood-meal before 9 p.m. Comparatively few entered a calf-baited hut after that time. On the other hand at a cattle-shed, large numbers of *C. vishnui* and *C. gelidus* were taken biting cattle at all hours of the night, with no period of peak activity, but *M. uniformis* had a period of peak activity immediately after dark. *C. p. fatigans* was rare at cattle-sheds.

Guelmino (D. J.). **The Physiology of *Anopheles maculipennis* during Hibernation. An Attempt to interpret the Phenomenon of Gonotrophic Dissociation.**—*Ann. trop. Med. Parasit.* **45** no. 2 pp. 161–168, 2 graphs, 4 refs. Liverpool, 1951.

Fertilised females of *Anopheles maculipennis* Mg. suspend their reproductive functions at the approach of the cool season and develop a fat-body to sustain themselves during the quiescent period. Roubaud advanced a theory [*R.A.E.*, B **11** 163] that diapause in Anophelines is brought about not by temperature but by cyclic asthenia or auto-intoxication due to inadequacy of excretory functions. The author believes, however, that it is a composite, physiological adaptation for hibernation, and that the changes that take place are completely dependent on temperature. He points out that the diapause in Anophelines always coincides with winter, is common in latitudes where the seasonal temperatures are contrasting, becomes shorter as the duration of winter decreases from north to south and does not occur in the tropics, and that *A. maculipennis* hibernates in the second or third generation of the year in northern Europe and in the fourth or fifth in the south.

An account is given of observations in Yugoslavia on hibernation in *A. maculipennis typicus*, which remains throughout the winter in warm stables housing livestock, and *A. m. messeae* Flni., which goes out to cold shelters. The movement by *messeae* to outdoor shelters takes place in late August or early September and is the first preparation made for hibernation. Oviposition ceased at the end of September at the comparatively high mean outdoor temperature of 15·5°C. [59·9°F.], but follicular activity of the ovaries continued until the end of October. Formation of adipose tissue began when oviposition ceased. Females containing ingested blood were found until early November, and at this time the blood remained unchanged for many days. From early November until the end of February, hibernation was complete with no reaction to light or touch. The migration back to stables containing livestock took place in early March when the fat-reserves were nearly exhausted, feeding was resumed and the ovaries reactivated. Out of 72 females collected in a stable on 14th March, 67 contained blood and 70 had active ovaries. The first eggs were laid in the laboratory on 17th March, when the mean outdoor temperature was 10·7°C. [51·26°F.].

In the case of *typicus*, preparations for hibernation did not begin until October, feeding continued during November and December, with formation

of adipose tissue to compensate for loss through activity, and ceased completely only during January, when the weather was coldest. Fresh blood in the ventriculus during winter showed no change of colour for 8–10 days or more. Oviposition ceased at a mean outdoor temperature of 11·5°C. [52·7°F.] and ovarian activity at 5–7°C. [41–44·6°F.]. If allowance is made for the difference between indoor and outdoor temperatures (5–6°C. [9–10·8°F.]), it is clear that the temperatures at which ovulation ceases in *messeae* and *typicus* are about the same. Feeding and follicular activity were resumed when outdoor temperatures began to rise in the second half of February, and oviposition began in early March when the mean outdoor temperature was 7·5°C. [45·5°F.].

The adipose tissue of the fat-body apparently supplies caloric energy, aiding resistance to cold, and renders nourishment superfluous until it has been consumed, when warmth again stimulates feeding. It also inhibits follicular activity. After hibernation, one blood-meal is sufficient for oviposition. It is possible that the follicles contain enough accumulated albuminous substance for egg-formation and that the blood-meal serves only as a stimulus to ovarian activity. Sudden falls of temperature for a few days in summer do not cause reproductive activity to cease. Only a progressive decrease in temperature effects the necessary change in metabolism.

Blackith (R. E.). **Bioassay Systems for the Pyrethrins. IV. Stoichiometric Relations with Pyrethrum Synergists.**—*Ann. appl. Biol.* **40** no. 1 pp. 106–112, 2 graphs, 18 refs. London, 1953. **V. Experiments with a resistant Strain of** *Calandra granaria* **L.**—*T.c.* pp. 113–120, 3 graphs, 15 refs.

In the first of these papers, which belong to a series [*R.A.E.*, B **39** 24, etc.], reference is made to spray tests against *Aëdes aegypti* (L.) in which the addition of increasing proportions of sesamin or N-isobutylundecylenamide increased the toxicity of pyrethrins until the molecular ratio of synergist to pyrethrins was 1:1, but no further change in toxicity occurred when the ratio was higher [**38** 36]. Further tests were carried out with pyrethrins and six synergists applied in oil to filter papers on which adults of *Calandra granaria* (L.) were subsequently exposed. A similar result was obtained when the synergist was sesamin, N-isobutylundecylenamide, piperonyl cyclonene, n-propyl isome (a condensation product of isosafrole and n-propyl maleate) or M. G. K. 264 (N-(2-ethylhexyl)bicyclo[2.2.1]-5-heptene-2,3-dicarboximide), the respective mixtures being 3, 1·8, 4·2, 2·3 and 2·2 times as toxic as the pyrethrins alone where the molecular rates of synergist to pyrethrins was 1:1 or higher. With piperonyl butoxide, however, the relative toxicity of the mixtures reached a peak of 8 when the ratio was 5:1 and became constant at 4·5 when it was 10:1 or higher. D.H.S. Activator (ethylene glycol ether of pinene) showed no synergistic activity in these tests [*cf.* **28** 181]. The molecular volumes of members of the pyrethrins complex all lie within the same limited range as those of the six effective synergists, and it is thus possible that the synergist molecules can replace molecules of pyrethrins almost exactly in films at the nerve interface [**38** 36]. In work with flying insects [**38** 34–36], the weight of pyrethrins accumulated within the fixed exposure period was less for insects treated at concentrations slightly above the minimum for paralysis than for those treated at the minimum concentration. This difference implies an increase in absolute toxicity of the pyrethrins, which may be associated with close-packing of the pyrethrin molecules once they have covered the nerve interface. If equivalent synergist molecules

formed part of the interfacial film, fewer pyrethrin molecules would be needed to induce close-packing and re-orientation of the molecule to discharge the resting potential at the interface more efficiently.

The second paper comprises an account of experiments noticed elsewhere [A **41** 310] in which strains of *C. granaria* somewhat resistant to pyrethrins were obtained by selection. The relative tolerances of the selected and unselected strains could not be well expressed by median response dose ratios, because the relevant regression lines were not parallel, and a new method, based on the " generalised distance " of P. C. Mahalanobis (1936) was adopted and is described. It gave improved stability and could also be used to compare two insecticides giving lines of different slope.

KERR (R. W.). **Adjuvants for Pyrethrins in Fly Sprays. I. The Adjuvant Action of some Essential Oils and other Materials from Australian Plants.**—*Bull. sci. industr. Res. Org. Aust.* no. 261 pp. 5, 7–31, 3 pls., 24 refs. Melbourne, 1951. **II. Adjuvant Activity and chemical Structure.**—*T.c.* pp. 5–6, 32–48, 15 refs. **III. The Mode of Action of Adjuvants.**—*T.c.* pp. 6, 49–63, 7 refs.

The following is substantially the author's summary. In the experiments described in the first part, 32 materials from Australian plants, including 22 essential oils and some of their constituent compounds, were incorporated at a concentration of 2 per cent. in standard pyrethrum sprays, which were then evaluated for insecticidal effect against house-flies [*Musca domestica* L.] by the Peet-Grady method. The toxicity of the standard spray was significantly increased by essential oils steam-distilled from the leaves of *Backhousia myrtifolia*, *Doryphora sassafras*, *Melaleuca bracteata* and *Zieria smithii* and from the wood of *Dacrydium franklinii* and *Eremophila mitchelli*, and by elemicin, methyl eugenol and evodionol. The leaf oil of *Atherosperma moschatum* was moderately effective; the other materials tested were inactive. At the same concentration, without pyrethrins, the effective oils and evodionol were non-toxic, so that in pyrethrum sprays they behave as adjuvants. Evodionol is a crystalline compound isolated from leaves of *Evodia littoralis* and structurally related to deguelin and toxicarol.

The adjuvant properties of the oils from *B. myrtifolia*, *D. franklinii*, *M. bracteata and Z. smithii* are due principally to their major constituents, *i.e.*, one or both of the phenol ethers, elemicin and methyl eugenol. Evidence leads to the conclusion that unidentified sesquiterpenes, and to a smaller extent safrol, are responsible for the adjuvant activity of the oil from *Doryphora sassafras*. Supplementary observations on the behaviour of the flies during exposure to the sprays showed that all these oils stimulate flight, whether or not pyrethrum is also present in the spray. They have no marked paralysing effects themselves, but increase the rate of knock-down caused by pyrethrum sprays. These properties are also contributed by the adjuvant principles of the oils. A gradual but considerable loss in toxicity of pyrethrum occurred in sprays containing the oil of *Tagetes glandulifera*. The inactivity of a sample of sesame oil proved to be due to the absence of sesamin.

Investigations on the relation between the chemical structure and the activity of adjuvants are described in the second part. An examination of the adjuvant properties of nine compounds related structurally to sesamin contributed further to the evidence of previous workers that the activity of sesamin is associated with the presence of methylenedioxy groups [*cf. R.A.E.*, B **38** 28, 111, 147, etc.]. Replacement of these groups by

methoxyl or hydroxyl groups, as in eudesmin, matairesinol and its dimethyl ether considerably reduced effectiveness. In several chemical series of phenol ethers, comprising 30 compounds, adjuvant activity was found to be related directly to the number of methoxyl groups present, while a methylenedioxy group is ineffective unless one or more methoxyl groups are also present. An allyl side-chain imparts greater activity than a propenyl in this type of compound, and saturated chains (up to C_5) are completely ineffective. The high activity of the American materials, sesamin, N-isobutyl undecyleneamide and Valone (2-isovaleryl-1,3-indandione) is confirmed. Valone and leptospermone, a compound of similar structure and insecticidal activity occurring in the oil of *Leptospermum scoparium*, both markedly increased the toxicity of the standard pyrethrum spray to which they were added, Valone being the more effective; and both had virtually no effect on the rate of knockdown or the activity of the exposed flies. The effects of the compounds examined on the behaviour of the flies during exposure to the sprays were recorded, and in general, those compounds that showed significant adjuvant effect also markedly increased the activity of the flies and the rate at which they were paralysed by pyrethrum sprays.

In the third part, some possible ways in which adjuvants may increase the mortality of flying insects exposed to atomised sprays, are discussed. Adjuvants are classified into two main types, those that increase the dosages of toxic material received by the insects and those that increase the toxicity of the acquired dosages. Using house-flies, tests especially designed to differentiate between these two types of action were carried out with materials chosen as being fairly representative of the pyrethrum adjuvants examined previously. One method, involving the application to individual flies of constant amounts of pyrethrins with and without adjuvant, prevented the adjuvants from increasing the dosages received, so that any increase in mortality would be due to increased toxicity. In the other method, the adjuvants were incorporated in sprays containing Thanite instead of pyrethrins, and tested by the Peet-Grady technique. The results of the tests, together with earlier observations, led to the conclusions that the pyrethrum adjuvants studied are not toxic to house-flies at the dosages used, but they increase considerably the toxicity of pyrethrum solutions and show some degree of specificity for pyrethrins, they increase the activity of flies during exposure, and they retard pyrethrum paralysis. All the adjuvants conformed to this pattern of behaviour, except one, leaf oil of *D. sassafras*, which differed only in accelerating pyrethrum paralysis.

Schechter (M. S.), Green (N.) & LaForge (F. B.). **Constituents of Pyrethrum Flowers. XXIV. Synthetic *dl-cis*-Cinerolone and other Cyclopentenolones.**—*J. Amer. chem. Soc.* **74** pp. 4902–4906, 25 refs. Easton, Pa., 1952.

The authors describe the synthesis of the five analogues of cinerolone of which the chrysanthemum monocarboxylic acid esters were tested as insecticides by Gersdorff & Mitlin [*R.A.E.*, B **39** 136], and of *dl-cis*-cinerolone, which was shown to be identical with the product from the natural source.

Here's an Answer to DDT-resistant Mosquitoes.—*Pest Control* **21** no. 4 pp. 20, 22, 2 figs. Painesville, Ohio, 1953.

As partial or complete failure of DDT and other chlorinated-hydrocarbon insecticides to control mosquitos had been reported in California [*R.A.E.*,

B **41** 47–48] and Florida, EPN (ethyl p-nitrophenyl thionobenzenephosphonate), which had been found to be an outstanding larvicide in the laboratory, was tried in the field in California in June 1952. The predominant species present were *Aëdes nigromaculis* (Ludl.) and *Culex tarsalis* Coq. In tests by C. M. Gjullin, sprays from either a 45 per cent. emulsifiable concentrate or a 25 per cent. wettable powder applied from a jeep at 0·035 lb. EPN per acre gave 100 and 99 per cent. kill of larvae of *C. tarsalis* and *A. nigromaculis*, respectively, in 24 hours. When 0·045 lb. EPN per acre was applied in emulsified solution from an aeroplane flying 25–50 ft. high, kills of the two species in 24 hours were 96 and 98 per cent.

Routine applications of 0·075 lb. EPN per acre from an aeroplane and jeeps were begun in June and extended to all rural breeding areas (flooded areas and irrigated pastures) by July. The sprays were delivered at 10 U.S. gals. per acre at 150–200 lb. pressure from the jeeps, and at about 1·2 U.S. gals. from the aeroplane. The precautions taken to safeguard the operators are described. No significant lowering of the blood cholinesterase activity of the men took place over a spraying season of three months. The water was 1–24 inches deep and much of the surface was partly covered with grass. Cattle on a pasture that was sprayed six times at intervals of 6–10 days with EPN showed no adverse effects.

Two other organic phosphorus compounds tested against the larvae, malathon and NPD [tetra-n-propyl dithionopyrophosphate] appeared to be only about 10 per cent. as effective as EPN.

Robinson (G. G.). **A Note on Mosquitoes and Yellow Fever in Northern Rhodesia.**—*E. Afr. med. J.* **27** no. 7 pp. 284–288, 8 refs. Nairobi, 1950.

A suspected case of yellow fever was encountered at Balovale in 1943, and although no other clinical cases are known to have occurred in Northern Rhodesia, over 7 per cent. of more than 3,000 blood samples from the population of the Balovale area yielded positive results in protection tests [*cf. R.A.E.*, B **37** 94]. Observations on mosquitos to investigate possible vectors were made periodically at Balovale, Livingstone and Ndola from 1945 onwards. Although *Aëdes aegypti* (L.), *A. simpsoni* (Theo.) and *A. luteocephalus* (Newst.) [*cf.* **16** 236] formed 31, 5 and 5 per cent., respectively, of 5,267 larvae collected from tree holes at Balovale, the species considered to be proved vectors of yellow fever (*A. aegypti*, *A. simpsoni* [**37** 150] and *A. africanus* (Theo.) [**41** 25, etc.]) formed less than 1 per cent. of the mosquitos attacking man at ground level at any of the three centres, and other tree-hole breeders were also rare. Over half the mosquitos at each centre were *Mansonia* (*Taeniorhynchus*) *uniformis* (Theo.) [*cf.* **35** 105] and *Anopheles coustani* Lav. and almost all of the others swamp- or pool-breeding species. *M.* (*T.*) *africana* (*Theo.*) [*cf.* **35** 105] formed 11 per cent. near Livingstone. Banana plants, which are a prolific source of *Aëdes simpsoni* in yellow-fever areas [**36** 205], are not extensively cultivated. It appears that the known vector species of *Aëdes* cannot be responsible for transmission of the virus to the human population since they are so seldom found feeding on man.

The dry season in Northern Rhodesia is very long, with six months of the year (April–October) almost rainless, and it was thought that the species of *Aëdes* could not maintain the virus over such a period [*cf.* **41** 93, etc.] as they were believed to survive it only as eggs, and there is no evidence that the virus is hereditarily transmitted [**41** 24–25]. However, evidence was collected at Livingstone and Ndola that several tree-hole mosquitos,

including seven species of *Aëdes*, survive the dry season in the adult stage. Small numbers of larvae were found regularly throughout the dry season in bamboo pots on trees near the river at Livingstone, which were emptied twice weekly, though not in pots on trees near a hospital about three miles from the river. At Ndola, bamboo pots were watched at the hospital, in dry bushland two miles from a dwelling and in a thicket on a river. *A. africanus* and *A. schwetzi* Evans were the commonest species found in the pots during the dry season, and *A. aegypti* and *A. simpsoni* were among those that occurred occasionally. A few females of *A. africanus* were taken at the end of the dry season in primitive traps with adhesive linings fixed over the pots. It is shown to be unlikely that the source of the ovipositing females was artificial containers in or near houses. In December 1946, ten larvae of *A. aegypti* were found with 62 of *A. vittatus* (Big.) [*cf.* **17** 213] in a rock pool containing rotting leaves near the Victoria Falls. It is possible that *A. aegypti* makes regular use of this type of breeding place in the dry season [*cf.* **34** 93]. These were the only larvae of tree-hole species found in ground or rock pools in spite of repeated searching for about two years each at Livingstone and Ndola. Larvae could not be found in tree holes between mid-May and early December. It was observed that 1–1·5 ins. rain over a period of 1–2 weeks was enough to initiate their appearance in some tree holes, though 3 ins. was necessary in most. Rock pools supported breeding of mosquitos in 1946 from January to the middle of February and from the last week of August to the end of the year. June and July were the only months when natural breeding-places must have been practically absent near Livingstone. They were also the coldest. It is possible that some adults of *A. aegypti* and related species pass through a resting stage at this time.

Papers noticed by Title only

Vargas (L.) & Martínez Palacios (A.). **Estudio taxonómico de los mosquitos anofelinos de México.** [A taxonomic Study of the Anopheline Mosquitos of Mexico.]—viii + 143 pp., 62 figs., 4 pp. refs. Mexico, D.F., Secret. Salub. Asist., Ofic. Camp. nac. Palud., 1950.

Freeborn (S. B.) & Bohart (R. M.). **The Mosquitoes of California.**—*Bull. Calif. Insect Surv.* **1** no. 2 pp. [2 +] 25–78, 49 figs., 31 refs. Berkeley, Cal., 1951.

Howe (R. W.). **The rapid Determination of the intrinsic Rate of Increase of an Insect Population.**—*Ann. appl. Biol.* **40** no. 1 pp. 134–151, 6 figs., 10 refs. London, 1953. [See *R.A.E.*, A **41** 311.]

Lord (K. A.), Ward (J.), Cornelius (J. A.) & Jarvis (M. W.). **Chromatographic Separation of the Pyrethrins.**—*J. Sci. Fd Agric.* **3** no. 9 pp. 419–426, 1 fig., 3 graphs, 14 refs. London, 1952.

Rousselot (R.). **Notes de parasitologie tropicale. Tome I. Parasites du sang des animaux (système réticulo-endothélial) A.O.F. (1942–1945) Iran (1946–1947) A.E.F. (1948–1952).**—152 pp., 44 figs., 5½ pp. refs. Paris, Vigot Frères, 1953. **Tome II. Ixodes.**—135 pp., 73 figs., 4 pp. refs. Price *Frs.* 2050.

These two volumes initiate a series on tropical parasitology. The first contains the results of the author's investigations on blood parasites of domestic and other animals and birds made in French West Africa in 1942–45 (pp. 7–123), in Persia in 1946–47 (pp. 125–140) and in French Equatorial Africa in 1948–52 (pp. 141–150). The parasites comprise protozoa and forms of uncertain position such as *Rickettsia*.

The introductory parts of the second volume include notes on the collection, preservation, study, rearing and control of ticks, the influence of climate on their life-history, and the general morphology of Ixodids and Argasids, and lists of the ticks of West Africa, the hosts of each, the species found on each host, the number of host changes during development in each species (if known) and the diseases if any that each species transmits. The distribution of the specimens collected is also shown. A systematic section comprises keys to families, groups, tribes, genera, subgenera and species. About half the work consists of an account of the morphology and hosts of each species, sometimes with notes on geographical distribution, duration of stages, and pathogenic importance. The behaviour of a strain of *Ornithodoros moubata* (Murr.) and one of *O. savignyi* (Audouin), both in the French Congo, and experimental transmission by the former of *Spirochaeta anserina* in fowls are described.

Eyles (D. E.). **Studies on** *Plasmodium gallinaceum*. **I. Characteristics of the Infection in the Mosquito,** *Aedes aegypti*.—*Amer. J. Hyg.* **54** no. 1 pp. 101–112, 5 graphs, 8 refs. Baltimore, Md., 1951. **II. Factors in the Blood of the Vertebrate Host influencing Mosquito Infection.**—*Op. cit.* **55** no. 2 pp. 276–290, 3 graphs, 16 refs. 1952. **III. Factors associated with the Malaria Infection in the Vertebrate Host which influence the Degree of Infection in the Mosquito.**—*T. c.* no. 3 pp. 386–391, 3 refs. **IV. A Comparison of the Susceptibility of** *Aedes aegypti*, *Anopheles quadrimaculatus* **and** *Anopheles freeborni*.—*Op. cit.* **56** no. 1 pp. 71–77, 9 refs.

Quantitative experiments described in the first part of this paper showed that the oöcyst infection that develops in females of *Aëdes aegypti* (L.) that have fed on fowls infected with *Plasmodium gallinaceum* is related to the density of gametocytes in the blood of the donor. Gametocyte counts of 1,000 and 10,000 per cu. mm. blood produced oöcyst rates of about 17·5 and 175 per gut, respectively. Very little work was done on sporozoites, but there were indications that these reached the salivary glands in numbers proportionate to the number of oöcysts and that transmission hardly ever failed. In the sporozoite-induced infections studied, there was no decline in infectivity of gametocytes as maximum parasitaemia was reached, though such a decline has been reported in blood-induced infections.

It is shown in the second part that constituents of the blood of the donor influence the infection that develops in a mosquito that feeds on it. To demonstrate this, it was necessary to develop a controlled technique for infecting mosquitos by feeding them on suspensions of parasites *in vitro*. This technique, in which mosquitos in lamp chimneys were allowed to engorge through sausage-casing membranes [*cf. R.A.E.*, B **33** 95], is described.

(1427) Wt. P9/3884 12/53 E.P. Ltd. Gp. 566. [B]

In the third part, factors connected with the physiological state of the vertebrate host are shown to influence infection in the mosquito. At the peak, or just after the peak, of severe blood-induced parasitaemia, the substitution of serum from an uninfected healthy fowl for the serum of the infected blood frequently led to a significant enhancement of the mosquito infection as compared with the infection from the unaltered blood. Likewise, the substitution of washed erythrocytes from uninfected fowls for a similar volume of serum, produced marked enhancement. Conversely, serum from heavily infected fowls at the peak of parasitaemia caused a decrease in mosquito infection when used to suspend infected cells taken from a fowl earlier in the course of the disease.

The comparative studies with three species of mosquitos described in the last part show that *Anopheles quadrimaculatus* Say is much less susceptible to infection with *P. gallinaceum* than is *Aëdes aegypti*, only 59 per cent. of females of the former showing oöcysts as compared with 99·6 per cent. of those of the latter, although the mean number of oöcysts per female did not differ greatly in the two species. Black spores frequently developed in *Anopheles quadrimaculatus*, and the number of sporozoites reaching the glands was not proportionate to the number of oöcysts. *A. maculipennis freeborni* Aitken, which was shown for the first time to be susceptible to *P. gallinaceum*, was, however, even less so than *A. quadrimaculatus*, and development of the parasites in it was demonstrated only to the oöcyst stage. Cessation of development immediately after penetration of the gut by the oökinetes was observed in both species of *Anopheles*.

Levi-Castillo (R.). **Die Epidemiologie des Buschgelbfiebers in der Küstenebene von Ecuador.** [The Epidemiology of Jungle Yellow Fever in the coastal Plain of Ecuador.]—*Z. Tropenmed. u. Parasit.* **4** pt. 2 pp. 254–265, 5 figs., 13 refs. Stuttgart, 1953. (With a Summary in English.)

A campaign for the eradication of *Aëdes aegypti* (L.) from the coastal plain of Ecuador was begun in 1946, and this mosquito could not be found there in 1951, when 53 cases of yellow fever occurred near Santo Domingo de los Colorados among workers in forest land. Since the disease was obviously of the jungle variety, mosquitos were collected in the vicinity, and it appeared certain that the principal vector was *Haemagogus spegazzinii falco* Kumm, Osorno & Boshell. The habits of this mosquito in Ecuador differed in some respects from those recorded elsewhere, notably in that it was not closely associated with the forest canopy. Its preferred habitat was bamboo forest, and it bred chiefly in bamboo stumps filled with rainwater and in the sappy interior of the lower internodes of the stems. The females gained access to the latter through holes made by birds and oviposited at the end of the rainy season on the inside walls. The eggs withstood desiccation for considerable periods and hatched when the rains returned. The pH value of the water in the stems was 5·2–6·3. The females kept close to the ground and attacked man and animals indiscriminately. They were restricted to the forest or to well shaded coffee or cacao plantations in it in which bamboo stumps had been left after clearing. They were attracted to sunlight and were most active between 9 a.m. and 4 p.m. Mating flights were observed and are described; the swarms of males were at a height of 50–80 ft., and the females flew up to them from ground level. The optimum temperature was 25–28°C. [77–82·4°F.] and the tolerated range of relative humidity 55–95 per cent. Adults kept in the laboratory were killed by greater humidity and higher temperatures.

The incubation period of the virus in the mosquitos was 12–15 days. The chief sources of infection were monkeys of the genera *Ateles*, *Alouatta* and *Cebus*, but certain rodents, edentates and marsupials were also suspected. An epizootic of yellow fever among monkeys that had spread from central America traversed about 280 miles in Ecuador in eight months. The rate of spread depended on climatic conditions. During the dry months of June–October, the average maximum and minimum temperatures in 1951 were 25°C. and 16°C. [60·8°F.]. Under these relatively cool conditions, the mosquitos were largely inactive and the disease was rare. Since control of the larvae of *H. s. falco* in the stems was impracticable, vaccination of all persons entering the infected area was made compulsory.

Hansens (E. J.). **Failure of residual Insecticides to control House Flies.**—*J. econ. Ent.* **46** no. 2 pp. 246–248, 3 refs. Menasha, Wis., 1953.

In view of the development of resistance to DDT in house-flies [*Musca domestica* L.] in New Jersey [*R.A.E.*, B **38** 4], a programme of barn spraying was begun in 1949 to investigate the effect of certain other insecticides and see how soon strains resistant to them would develop. The work in the first season has already been noticed [**39** 120]. Subsequently, studies of γ BHC as lindane, p,p′methoxy-DDT (methoxychlor), chlordane and dieldrin as wettable-powder suspensions and lindane in emulsified solution also were continued in the same barns until 1952. The sprays were applied to leave a deposit on walls, ceilings and stanchions and gave control for a month or more after each application until the end of 1951. Lindane and methoxy-DDT were recommended for practical use because they were quicker in action and safer than chlordane or dieldrin. In 1952, they failed to give control, and alternatives were tried. Barns sprayed since 1949 with lindane were sprayed with methoxy-DDT, and those treated with methoxy-DDT, chlordane or dieldrin were treated with lindane, except that one chlordane-treated barn was sprayed with synergised pyrethrum. Little control was effected by any treatment, and laboratory tests on flies from some of the barns showed them to be resistant to all five of the chlorinated insecticides. Lindane with a synergist was then tried as a deposit and lindane with TEPP [tetraethyl pyrophosphate] and syrup sprinkled on floors, but both failed to give more than immediate kill. The only commercially available material that gave at all satisfactory results was 25 per cent. wettable Dilan [a 1:2 mixture of 1,1-bis(p-chlorophenyl)-2-nitropropane and 1,1-bis(p-chlorophenyl)-2-nitrobutane] at 32 lb. per 100 U.S. gals. spray, which gave control for three weeks in the only barn in which it was tried.

Miles (V. I.) & Wilcomb jr. (M. J.). **Control of native Rodent Fleas with DDT applied to simulate aerial Dusting.**—*J. econ. Ent.* **46** no. 2 pp. 255–257, 2 refs. Menasha, Wis., 1953.

Several foci of sylvatic plague were discovered in western Texas in 1947–49, and a method of controlling the fleas of wild rodents over a wide area would be needed if the infection spread to centres of human population. In an endeavour to find such a method, three large ranchland plots harbouring pack rats (*Neotoma micropus*) infested by fleas, of which the predominant species were *Echidnophaga gallinacea* (Westw.) and *Orchopeas sexdentatus* (Baker), were dusted with mixtures of DDT and pyrophyllite at 1, 3 and 5 lb. pure DDT per acre, respectively, by the use of hand-operated rotary dusters; the dust was applied evenly over the whole area to simulate

aeroplane dusting. Two similar plots were observed as controls. Collection of fleas from pack rats trapped alive from all plots one week before and 1, 2 and 4 weeks after dusting showed that fleas other than *E. gallinacea* were reduced by the highest dosage of DDT (the numbers per host at the successive counts being 14, 0·3, 6·2 and 5·3) and indicated that some slight reduction was effected by the lower dosages one week after treatment. Effectiveness was apparently lost within two weeks, although there were no heavy dust storms or rains. *E. gallinacea* was not significantly affected by the DDT. The results of this very limited experiment are thought to indicate that with due consideration for climate, soil and vegetation types, host species and other factors, temporary reduction of fleas on native rodents might be achieved by applying DDT from aircraft.

Schoof (H. F.) & Mail (G. A.). **Dispersal Habits of *Phormia regina* in Charleston, West Virginia.**—*J. econ. Ent.* **46** no. 2 pp. 258–262, 2 maps, 5 refs. Menasha, Wis., 1953.

Release of about 8,000 marked adults of *Phormia regina* (Mg.) from each of two sites in Charleston, West Virginia, during 1951 and 1952 and subsequent trapping revealed dispersal for distances up to nearly ten miles in three days and just over ten miles on the fourth day, though most of the marked flies recaptured were taken within five miles of the site of release [*cf. R.A.E.*, B **40** 177]. It was shown that flies moved from a zone with a low standard of sanitation to all parts of the city, and that their migration was not prevented by the presence of wooded ridges 400–500 ft. high or by watercourses. The findings supported the recommendation that to effect the maximum reduction of *P. regina* within a community, control operations should be extended to sites of prolific breeding 3–4 miles beyond the boundaries of the urban area.

The method adopted to mark the flies was to feed them on radioactive milk (containing 1 millicurie P^{32} as phosphoric acid per litre) and then dust them with a red or green dye. They were detected in the trap catches by their radio-activity and then treated with acetone to expose the dye characteristic of the point of release.

Morril jr. (A. W.). **Army Insect Control Operations in the Far East.**—*J. econ. Ent.* **46** no. 2 pp. 270–276. Menasha, Wis., 1953.

The organisation of insect control by the Corps of Engineers of the United States Army in the Far East after the end of the Second World War is described. In addition to work noticed elsewhere [*R.A.E.*, A **41** 356], the operations comprised control of the Anopheline vectors of malaria, other disease-carrying mosquitos and flies (including *Musca*, *Chrysomyia* and *Lucilia*), *Simulium* (*Eusimulium*) *equinum* (L.), which was troublesome in Japan, and sundry pests such as *Psychoda alternata* Say and *Chironomus dorsalis* Mg. Since flies were found to be carried on trucks in great numbers for as much as ten miles, all trucks going into fly-breeding areas were sprayed weekly with 5 per cent. DDT in kerosene. It was found possible to control larvae of Anophelines and other mosquitos in rice-fields by shaking 10 per cent. DDT dust over the fields from a cloth bag. Extensive tests in the Philippines on the effectiveness of sprays discharged from aircraft against larvae of *Anopheles minimus* var. *flavirostris* (Ludl.) and of fogs against larvae and adults of this and other mosquitos in areas covered with heavy grasses showed that sprays failed to penetrate the grasses, but 5 per cent. DDT in diesel oil applied from an aeroplane flying at a height of 50 ft.

between 5 and 6 a.m. gave excellent control when the grass was previously cleared or burnt. Adults of *A. m. flavirostris*, which normally rest in the cover at the breeding sites during the day, were not affected by the sprays except when the cover was reduced. Dusts gave good control of larvae at all times. Results with 5–20 per cent. DDT solutions in fogs in various rural and urban areas were uniformly disappointing, but some fogging in Japan and Okinawa with a semi-thermal type of generator gave particles of a good size and was fairly effective against adult mosquitos. The use of fogs was not encouraged, and more reliance was placed on sanitation and basic measures, which are described.

Metcalf (R. L.) & March (R. B.). **The Isomerization of Organic Thionophosphate Insecticides.**—*J. econ. Ent.* **46** no. 2 pp. 288–294, 1 graph, 17 refs. Menasha, Wis., 1953.

The thionophosphate insecticides dealt with in the investigations described included parathion, methyl-parathion and isopropyl-parathion (O,O-diethyl, O,O-dimethyl and O,O-diisopropyl O-p-nitrophenyl thionophosphate), malathon (O,O-dimethyl S-(1,2-dicarbethoxyethyl)dithiophosphate) and EPN (ethyl p-nitrophenyl thionobenzenephosphonate), and their isomerisation was by exchange of the double-bonded sulphur on the phosphorus atom for double-bonded oxygen.

Early studies on the mode of action of parathion in mammals and insects indicated that it was a strong inhibitor of cholinesterase *in vivo* and inactivated about 50 per cent. of various cholinesterases at concentrations of the order of 10^{-6} M. *in vitro*, but more recent work has shown that very highly purified parathion is a feeble inhibitor of cholinesterases *in vitro* and that impure preparations are much more active, owing to the presence of traces of the parathion isomeride, O,S-diethyl O-p-nitrophenyl thiophosphate, which is a very active anticholinesterase. Investigations were therefore carried out with the various materials to determine the effect of isomerisation on their mode of action and toxicity to insects and mammals.

Highly purified samples were tested for toxicity to house-flies [*Musca domestica* L.] by topical application, for oral toxicity to white mice by administration in propylene-glycol solutions, and for inhibition of fly-brain and mouse-brain cholinesterases by the manometric method [*R.A.E.*, A **39** 174], before and after isomerisation by heating to a temperature of 150°C. in sealed tubes for varying periods. The isomerised products contained only small amounts of thiono-sulphur, and were shown by paper chromatography to consist of mixtures of compounds, of which the S-alkyl isomerides were the chief constituents. The degree of isomerisation, as measured by reduction in thiono-sulphur content, was 83 per cent. in 3·5 hours and 91 per cent. in 6·5 hours for methyl-parathion, 80 and 94 per cent. in 24 hours in two tests for parathion, about 90 per cent. in 24 hours for malathon and 20 per cent. in 24 hours for EPN. Isomerised samples of methyl-parathion, parathion, malathon, EPN and isopropyl-parathion were all more effective as inhibitors of fly-brain cholinesterase and less toxic to flies than the untreated compounds, and those of methyl-parathion and parathion more active inhibitors of mouse-brain cholinesterase and less toxic to mice than the untreated compounds; the other materials were not tested with mice. Tests with standard sodium-hydroxide solutions at 37°C. to determine whether the lower toxicity of the isomerides might be due to increased susceptibility to hydrolysis showed that the isomeride of parathion was hydrolised nearly 300 times as rapidly as parathion. That of methyl-parathion gave less clear-cut results, 20 per cent. hydrolysis occurring in ten minutes, after which the process almost completely ceased.

Since isomerisation of the thionophosphates greatly increased their effectiveness as anticholinesterases, a graph relating the percentage cholinesterase inhibition to the concentration of nearly pure isomeride can be used to measure extremely small amounts of isomeride; such a graph is given for 91 per cent. isomerised parathion.

In further studies of isomerisation, a solution of 1×10^{-2} M. purified methyl-parathion in ethanol was isomerised by heating at 100°C. for 0·5–4 hours, the amount of isomeride formed being directly proportional to the period of heating and reaching about 30 per cent. in four hours, but not at all by heating at 50°C. for the same period. Slight isomerisation occurred on exposure to ultraviolet irradiation for 24–72 hours at 19°C. Isomerisation also took place when the solution was left standing in the laboratory for five months, the percentage inhibition of fly-brain cholinesterase at a dilution of $3{\cdot}3 \times 10^{-5}$ M. increasing from 5 to 94.

A knowledge of the isomerisation of thiophosphate insecticides is important, since the presence of the isomerides may give very misleading values as to anticholinesterase activity, hydrolysis rates and toxicity, and their formation affect the decomposition of residues on plants. Samples of technical parathion were shown to contain 5–20 per cent. S-ethyl isomeride and a sample of technical O,O-diethyl O-2-(ethylmercapto)ethyl thionophosphate (the active ingredient of Systox) contained only 52 per cent. of the theoretical amount of thiono-sulphur, indicating the presence of nearly equal amounts of the thionophosphate and the isomeride O,O-diethyl S-2-(ethylmercapto)ethyl thiophosphate.

Pimentel (D.), Schwardt (H. H.) & Dewey (J. E.). **Development and Loss of Insecticide Resistance in the House Fly.**—*J. econ. Ent.* **46** no. 2 pp. 295–298, 2 refs. Menasha, Wis., 1953.

The method adopted for estimating the resistance of the house-flies [*Musca domestica* L.] to the various insecticides used was to expose the flies for 12 hours in screen cages that had been treated by passage through a spray cone at a constant speed. Five concentrations of insecticide were used, and the criterion of resistance was the concentration estimated to be required for knockdown of 50 per cent. of the flies (KD 50). The method of selecting a strain for resistance to an insecticide was to breed successive generations from flies that had resisted an exposure to a deposit that gave 98 per cent. knockdown (90 per cent. in the case of dieldrin).

The development and loss of resistance to DDT was studied in a strain (A) produced by inbreeding from highly resistant flies collected in September 1949 from a dairy barn in New York. The KD 50 when the experiments began was 10 per cent. for males and 28 per cent. for females. The strain was selected for resistance for 26 generations. By the fifth generation, about 3 per cent. of the flies survived exposure for 2·5 weeks on a deposit of 4 gm. DDT per sq. ft. In the tenth generation, exposure for 12 hours in test cages treated with 30 per cent. DDT knocked down only 2 per cent. of the males and no females and by the 20th, 70–80 per cent. survived exposure for two weeks on a deposit of 4,000 mg. per sq. ft. No further increase in resistance occurred in the next six generations. The flies of the 26th generation were about 10 times as resistant to lindane [γ BHC], 3 times as resistant to dieldrin and 6 times as resistant to parathion as those of the first. A strain (A_1) reared from the 20th generation of strain A without further exposure to insecticide lost all its resistance in 22 generations.

When a strain (B) established from the first generation of strain A and

another (C) established from normal flies were selected for resistance to lindane, both showed a rapid increase in resistance, and there was no significant difference between them. A strain (C_1) split off from the 17th generation of strain C and maintained without further exposure to insecticide lost its resistance to lindane in 20 generations. No decrease occurred in the DDT-resistance of strain B. Strains established from two DDT-resistant strains (H and O) collected from dairy counties in New York and reared for two generations without exposure to insecticides were selected for resistance to dieldrin. They resisted three times as much in the tenth generation as they did in the first, and their resistance to DDT had remained the same or increased. Flies of the same strains concurrently inbred without exposure to insecticides, lost their resistance to DDT in 12 and 20 generations, respectively, though the change in resistance from generation to generation was erratic in the second, which was initially the more resistant, of the two strains. After DDT-resistant flies (W strain) had been selected for resistance to parathion for ten generations, the strain was about 9 times as resistant to parathion as it was in the first generation and its resistance to DDT had also increased. Flies of the same strain concurrently reared without exposure to insecticide lost their DDT-resistance in 12 generations.

It is concluded that the rate of development of insecticide-resistance depends on the degree of selection and that there were indications that the rate of development of resistance is also related to the particular insecticide. There appeared to be a limit to the extent to which a strain can resist a particular insecticide.

Goodwin (W. J.) & Schwardt (H. H.). **House Fly Control in New York State Dairy Barns.**—*J. econ. Ent.* **46** no. 2 pp. 299–301, 4 refs. Menasha, Wis., 1953.

During 1951 and 1952, 172 dairy barns in New York State were treated with various insecticides for the control of house-flies (*Musca domestica* L.) by either the overall, spot or strip method of application. In the overall method, the entire inside barn surface except the floor is sprayed with 1 U.S. gal. per 300 sq. ft. The spot method consists of spraying the centre part of the barn ceiling and the areas around the calf pens and around the barn entrances with spray three times as concentrated as that used in the overall method. The materials applied by the overall method were γ BHC as lindane, DDT with or without a synergist [1,1-bischlorophenylethane], and a mixture of p,p′methoxy-DDT (methoxychlor) with lindane, in both years, lindane with a synergist [2-hydroxy-decachloro-4,7-methanoindan-1-one] in 1951, and Dilan [*R.A.E.*, B **41** 171] in 1952, while lindane and dieldrin were applied by the spot method in both years. The strip method was used with dieldrin only. Screen wire was cut into strips 1–2 ins. wide, which were dipped in an 18·5 per cent. dieldrin emulsion concentrate, allowed to dry and hung up lengthwise 6 ins. below the ceilings of the barn at intervals of 2–3 ft. Cloth and string, the latter hung at intervals of one ft. were also used as substitutes for screen. All treatments except lindane alone by the overall method gave more than four weeks' control in 1951, which was considered satisfactory, but none gave effective control by the overall or spot method in 1952. By the strip method, dieldrin gave effective control for two years if it had not been used previously, but resistance built up during the third year. Lindane vaporised in one barn at 2 gm. per day per 28,000 cu. ft. failed to give adequate control. The necessity for good sanitation to supplement chemical measures is stressed.

Tahori (A. S.) & Hoskins (W. M.). **The Absorption, Distribution and Metabolism of DDT in DDT-resistant Houseflies.**—*J. econ. Ent.* **46** no. 2 pp. 302–306. Menasha, Wis., 1953.

Previous work has shown that certain strains of DDT-resistant house-flies [*Musca domestica* L.] can change absorbed DDT into the relatively non-toxic DDE [*R.A.E.*, B **39** 211]. However, the fact that apparently healthy DDT-resistant flies can store in their bodies amounts of DDT that would rapidly kill susceptible flies if applied topically to their integument [*cf.* **41** 123] suggests that there is a second defence mechanism. Almost invariable failure to recover all the administered dose as DDE or unchanged DDT indicates that one or more additional degradation reactions may produce compounds that do not respond to the Schechter-Haller test [*cf.* **35** 196; **39** 212]. The work described was designed to gain information on the penetration of DDT into the bodies of resistant flies, the accumulation of DDT and of DDE after single and multiple applications and the effect of temperature on absorption and detoxification of DDT. Females 3–5 days old of the Berkeley, Super Laton and Bellflower strains [*cf.* **40** 55] and a moderately resistant Phoenix strain were used, and purified p,p'DDT was applied topically in acetone solution to the ventral thorax. Procedure is described. At first, DDA was determined as well as DDT and DDE, but as no appreciable amount was ever found, this process was omitted in the latter part of the work. Repeated reference is made in the text to tables that contain the data on which many of the conclusions are based, but these and a graph to which reference is also made are lacking.

In studies of penetration, the total amount of DDT absorbed was calculated as the difference between the DDT applied and the sum of that remaining on the surface of the insects and that lost to the container by being brushed off or excreted. It was found that the percentage absorbed is less as the applied dose increases, that flies that die within 24 hours absorb less in this time than those that survive, that the addition of piperonyl cyclonene lowers absorption of DDT into both flies that survive and those that do not, and that the amounts penetrating increase with rising temperature both with and without added piperonyl cyclonene. Plotting dosage against percentage absorbed in 24 hours by surviving flies gives a descending curve of decreasing slope. The marked decrease in the fraction absorbed indicates that the median lethal doses (LD 50) of hundreds or even thousands of μg. reported for some strains refer largely to unabsorbed toxicant. Loss to the container would be expected to increase with the applied dose but was not an important factor. Phoenix-strain flies, like those of the other resistant strains, absorbed DDT rapidly for the first 3–4 hours and much more slowly thereafter.

The probable explanation of the retarding of penetration in the presence of piperonyl cyclonene is that the larger molecules of the latter enter slowly and meanwhile hold the DDT in solution. Moreover, penetration in the later stages is slowed down as a result of the greatly increased mortality when the synergist is present. DDE penetrated readily into Bellflower flies and was held back by piperonyl cyclonene.

Many analyses were made of whole flies following absorption of determined amounts of DDT after a single application and after repeated applications at intervals of 24 hours. The difference between the amount of DDT that entered and that found at any time permitted calculation of the fraction metabolised. That not present as DDE is called X, as its nature has not been determined. After application, absorbed but unchanged DDT increases in amount for several hours during the period when symptoms

are developing. Survival seemed to depend on reduction in the amount of DDT, whereas flies that succumbed contained even more than during the time of greatest activity. Average amounts in μg. found in living and in dead flies at 24 hours were 0·015 and 0·028 in the Berkeley strain, 0·12 and 0·38 in the Super Laton strain, 0·23 and 0·43 in the Bellflower strain and 0·1 and 0·14 in the Phoenix strain. After 24 hours, symptoms of DDT poisoning are not usually shown, and the unchanged DDT in the body continues to decrease slowly.

Calculations of the amounts of DDT and DDE in extracts from flies were based on readings of optical density at two wave-lengths, 530 and 600 mμ, corresponding to the peaks of absorption for these two substances. An unidentified degradation product with an absorption maximum at about 385 mμ was also found to be present. The rate of increase in the amount of DDE present after the application of DDT is greatest in the first few hours and decreases steadily thereafter. In a number of cases, a maximum amount of DDE has been found after one or two days and a noticeable loss occurred thereafter. This would indicate that DDE is converted into a form that does not respond to the Schechter-Haller test. X always increases as the flies continue to live. The curve is of the same type as that for DDE, but the initial increase is considerably steeper. In surviving flies, the ratio X/DDE has high values shortly after application of DDT. These decline to a minimum at about two days and then slowly rise due to the simultaneous decrease of DDE and continuing rise of X. When death occurs, less DDE is formed, and usually less X, though not in all cases. It has previously been shown that DDT penetrates into flies killed by heat but is not metabolised, probably because the enzyme needed has been inactivated. Metabolism in 12 hours in Bellflower flies treated after being killed by carbon dioxide was much less than in flies that survived the observation period but comparable to that in those that died in the course of it. Temperature has a marked effect on penetration of DDT. Data for the application of 5 μg. DDT to Bellflower flies with an LD 50 of 20 μg. show that the unchanged DDT at 24 hours is decreased in later periods and that the X/DDE ratio rises with time at all the three temperatures studied (13·5°, 26° and 32·5°C. [56·3°, 78·8° and 90·5°F.]). The absorption of second and subsequent applications, tested on Bellflower and Phoenix flies, was as high as that of the first dose. Some surviving Phoenix flies contained more DDT than those that succumbed. This was noted often in this strain but not in the others. The ratio X/DDE becomes rather large after 3–4 days. In the case of repeated applications, metabolism to X was considerably increased over that following a single application.

Zeid (M. M. I.), Dahm (P. A.), Hein (R. E.) & McFarland (R. H.). **Tissue Distribution, Excretion of $C^{14}O_2$ and Degradation of Radioactive Pyrethrins administered to the American Cockroach.**—*J. econ. Ent.* **46** no. 2 pp. 324–336, 6 figs., 21 refs. Menasha, Wis., 1953.

The following is mainly based on the authors' summary. The internal distribution in the tissues of *Periplaneta americana* (L.) of pyrethrins labelled with C^{14} by biosynthesis [*R.A.E.*, B **40** 176] and their metabolites was determined in male and female cockroaches about four hours after mesothoracic interspiracular administration of lethal doses. The data from these distribution studies are summarised in a table, which shows that, of the tissues dissected (fore-, mid-, and hind-intestine, brain, thoracic ganglia, thoracic muscle and abdominal fat), the fore-intestine contained the greatest

amount of radioactivity (20·2 per cent. of the total in males and 16·6 per cent. in females), and that 65·7 per cent. in males and 74·8 per cent. in females was in the remainder of the insect body.

A comparison was made of the conversion of the radioactive insecticides to $C^{14}O_2$ following administration to cockroaches of both sexes by interspiracular perfusion, injection into the haemocoele, feeding in acetone and maize-oil solutions, and contact with a deposit on a glass surface. The percentage of radioactivity excreted as $C^{14}O_2$ and measured as $BaC^{14}O_3$ was highest when the insecticides were administered by interspiracular perfusion. The results of these experiments are compared both in tabular form and in a series of graphs.

The detection of microgram quantities of pyrethrins, cinerins, keto-alcohols and chrysanthemum acids by paper chromatography and the application of these techniques to the study of possible metabolites are also described. The widespread distribution of radioactivity in the dissected tissues and remainder of the insecticidally-treated cockroaches was confirmed also by radiometric evaluation of paper chromatograms of acetone extracts of the various tissues. It is tentatively concluded that a large part of the radioactive pyrethrins and cinerins are hydrolysed in the insects to corresponding keto-alcohols and chrysanthemum acids.

Ludvik (G. F.). **Topical Application of Insecticide Solutions to** *Anopheles quadrimaculatus*.—*J. econ. Ent.* **46** no. 2 pp. 364–365, 5 refs. Menasha, Wis., 1953.

Disadvantages of exposure to treated surfaces as a means of obtaining comparative data on the toxicity of chlorinated-hydrocarbon insecticides to mosquitos are indicated, and an account is given of the technique by which topical application was made to adults of *Anopheles quadrimaculatus* Say. Immobilisation is necessary and was achieved by exposing the mosquitos, in groups of 15, for 30 seconds to carbon dioxide flowing into a 6 × 8 in. battery jar at 0·3–0·5 cu. ft. per minute. For treatment, the mosquitos were grasped with forceps by the wings, the legs being too fragile. Many solvents produced high mortalities among the mosquitos, but ethanol proved satisfactory if the volume used did not exceed 0·5 cu. mm. A device for applying the insecticide is described. The liquid reservoir is a 0·25 cc. tuberculin syringe with the shaft of the needle bent at 90° and the point ground flat. Lever stops ensure the delivery of a predetermined volume of solution, and left-hand operation allows of manipulation of the insects with the right hand.

The 50 and 90 per cent. lethal doses of nine insecticides applied in this way to *A. quadrimaculatus* are shown in a table. The dosage-mortality curves of p,p′DDT, p,p′DDD (p,p′TDE), methoxy-DDT (technical methoxychlor), chlordane, dieldrin, toxaphene and malathon were essentially parallel, as were those of lindane and allethrin, but the slope of the latter group was much steeper than that of the former. Allethrin and malathon were the most toxic, dieldrin and lindane were considerably more toxic than DDT, and the other four insecticides were less toxic.

Hansens (E. J.) & Bartley (C. E.). **Three new Insecticides for Housefly Control in Barns.**—*J. econ. Ent.* **46** no. 2 pp. 372–374, 1 fig., 3 refs. Menasha, Wis., 1953.

Three new chemicals developed and tested in Switzerland were studied in 1952 in New Jersey for the control of house-flies [*Musca domestica* L.].

They are 1-phenyl-3-methyl-pyrazolyl(5) dimethyl carbamate, 2-n-propyl-4-methyl-pyrimidyl(6) dimethyl carbamate and O-O-diethyl O-(2-isopropyl-4-methyl-pyrimidyl(6)) thiophosphate, to which the names Pyrolan, Pyramat and Diazinon have been assigned. Pyrolan is crystalline and the other two are liquids: all three are readily soluble in most organic solvents. Pyrolan is stated to be soluble at 0·2 per cent. in water at 20°C. [*cf. R.A.E.*, B **41** 69] and Diazinon at 0·004 per cent. All three have strong anti-cholinesterase action. The oral doses (mg./kg.) that give 50 per cent. kill of rats and mice are 53·5 and 46 for Pyrolan [*cf. loc. cit.*], about 200 and 200 for Pyramat, and 100 and 50–100 for Diazinon.

As Wiesmann reported that Pyrolan gave protracted control when combined with DDT [**41** 71], it was decided to test all three compounds with a similar insecticide, p,p′methoxy-DDT (methoxychlor). Diazinon and Pyramat were also applied alone. All, including the methoxy-DDT, were used at 1 per cent., and Pyramat alone also at 2 per cent. All the formulations except one of Pyrolan were wettable powders. Applications were made to all walls and ceilings of barns at 1 U.S. gal. spray per 400 sq. ft. at a pressure of 100–150 lb. Diazinon gave excellent control for the whole season (72 days) in a horse barn and 3 weeks' control in a dairy barn against non-resistant flies, and 30 days' control with methoxy-DDT in a barn in which the flies were resistant to γ BHC as lindane and methoxy-DDT. It was not tested alone against resistant flies. In all barns in which it was being used, some dying flies could still be found even when re-treatment was necessary. Pyramat and Pyrolan were not sufficiently lasting in their action to be used economically against house-flies in dairy barns. Pyramat gave very rapid initial kill and is thought to have promise as a contact insecticide with quick knockdown for use in combination with other insecticides.

Heal (R. E.), Nash (K. B.) & Williams (M.). **An Insecticide-resistant Strain of the German Cockroach from Corpus Christi, Texas.**—*J. econ. Ent.* **46** no. 2 pp. 385–386, 2 refs. Menasha, Wis., 1953.

It was reported in March 1952 that difficulty in controlling *Blattella germanica* (L.) in certain establishments in Corpus Christi, Texas, had been encountered for about a year, and that the cockroaches were found surviving in places adequately treated with a 2 per cent. solution of chlordane in oil. To ascertain whether resistance to chlordane had developed in the cockroaches, a strain was reared from individuals trapped locally and tested in comparison with a laboratory strain. In an experiment by a direct-spray method, 2 per cent. chlordane solution was applied to males of the first laboratory generation of the local strain and a laboratory strain and the percentages dead in 48 hours were 6·2 and 100, respectively. In further tests, chlordane, γ BHC as lindane and DDT were applied at various concentrations in acetone solution by a measured-drop technique to the ventral thorax and coxal membranes of adults of the two strains; those of the local strain were a mixture of the second and third generations. Mortality counts were made after five days, and the results for each sex are given in a table. It is concluded from them that the strain from Corpus Christi was more than 100 times as resistant to chlordane, 10–12 times as resistant to lindane and 5–6 times as resistant to DDT as the laboratory strain. General difficulty in controlling cockroaches has not been reported from any other part of the United States.

Roberts (F. H. S.). **The Tail-switch Louse of Cattle,** *Haematopinus quadripertusus* **Fahrenholz.**—*Aust. vet. J.* **26** pp. 136–138, 2 figs., 6 refs. Sydney, 1950.

Cattle lice in the collection of the Queensland Department of Agriculture and Stock were found to include specimens of *Haematopinus quadripertusus* Fahrenholz [*cf. R.A.E.*, B **37** 117] from Queensland, New Guinea, the Solomon Islands and the West Indies. A key to the Anoplura found on cattle in Australia is given; they comprise *H. quadripertusus*, *H. eurysternus* (Nitzsch), *H. tuberculatus* (Burm.), *Linognathus vituli* (L.) and *Solenopotes capillatus* End.

Legg (J.). **A preliminary Note on the Use of two recently introduced Insecticides, Chlordane and Toxaphene, in the Control of the Cattle Tick** (*Boophilus microplus*).—*Aust. vet. J.* **25** pp. 65–66. Sydney, 1949. **Diethyl-p-nitrophenylthiophosphate (E605): a Note on its Effects on the Cattle Tick** (*Boophilus microplus* **Canestrini**).—*Op. cit.* **26** pp. 9–10, 1 ref. 1950. **A further Note on the Use of synthetic Insecticides in the Control of Cattle Tick** (*Boophilus microplus* **Canestrini**)**: Some preliminary Observations with "497."**—*T. c.* pp. 141–142, 4 refs.

These three papers comprise accounts of preliminary experiments in Australia on the control of *Boophilus annulatus microplus* (Can.) by spraying infested cattle with chlordane, toxaphene, parathion (E605) or dieldrin (497). All the sprays were prepared from emulsion concentrates and, except in some of the tests with parathion, they caused no injury to the cattle at the concentrations used. Chlordane also caused no injury at 1 per cent.

Four cows infested with many thousands of ticks of a strain believed to be arsenic-resistant were sprayed late in April 1948 with 0·25 per cent. chlordane. Large numbers of females that reached maturity within two days of spraying dropped off apparently little affected, and many laid viable eggs, but the number maturing then declined and no engorged females were seen after the fifth day. Younger ticks were dying or dead by the fifth day, and the absence of appreciable numbers of larvae on the cows indicated that the effect of the deposit was lasting. Spraying was repeated at intervals of 28 days until September, and no engorged female was seen although the animals were artificially infested from time to time with several million larvae. The number that might have developed and escaped detection could not have been more than a small fraction of 1 per cent. of the number applied.

Sprays containing 0·65 or 0·55 per cent. toxaphene gave practically complete kill of all ticks on heavily infested cattle, including females in the last 2–3 days of life on the host. Considerably lower concentrations also gave high kills.

The first tests with parathion were made with two preparations designed for use against horticultural pests, one stated to contain 20 per cent. E605 and 7 per cent. other ethyl thiophosphates and the other 70 per cent. E605, and a third preparation stated to contain 35 per cent. E605. Each was diluted in water to 1:10,000 of the active principle and applied as a spray with a stirrup pump to cattle heavily infested with ticks in all stages. The first rapidly arrested infestation on a heifer, destroying all young adults. A few engorged females removed during the 48 hours after spraying laid viable eggs, and a few fully engorged nymphs survived and developed into females that engorged, but it was estimated that in general the kill was

more than 99 per cent. No untoward effect of any kind on the heifer was noted. The treatment was repeated on five other animals and gave about 98–99 per cent. kill of ticks without harming the host. The second preparation gave about 80 per cent. kill of ticks on four animals, some ticks of all stages escaping. Two animals showed considerable dermatitis. The third gave estimated kills of only 50–60 per cent. on four animals, and considerably damaged their skin. The inconsistent results are attributed to the different emulsifying agents used. When an E605 preparation containing 20 per cent. active principle and designed for use on livestock was tested at concentrations of 1:10,000, 1:15,000 and 1:20,000 of the active principle in water on eight animals, the highest concentration killed large numbers of ticks of all ages except fully engorged nymphs within a few hours. Some of the engorged nymphs shrivelled after showing no apparent effect for several days, and kill was nearly complete. Some adults removed immediately after treatment at the medium concentration laid viable eggs, and a small number of engorged nymphs reached maturity, but the overall kill was estimated at about 98 per cent. At the lowest concentration, a few females survived to lay viable eggs, and a higher proportion of engorged nymphs reached maturity than with the stronger treatments, but the proportion surviving was estimated at less than 5 per cent. No harmful effects on the animals were seen.

Dieldrin as a 0·1 per cent. spray on a very heavily infested animal caused the death of nearly all young adults, young nymphs and larvae within 24 hours, and the older adults and the engorged nymphs eventually dried up. When concentrations between 0·02 and 0·1 per cent. were tried, kill of ticks was over 99 per cent. in all cases.

Holstein (M.). **Un nouveau vecteur du paludisme en A. O. F.** *Anopheles rufipes* **(Gough 1910).**—*Bull. Soc. Path. exot.* **43** no. 3–4 pp. 140–143, 6 refs. Paris, 1950.

It was believed that *Anopheles gambiae* Giles, *A. g. melas* Theo. and *A. funestus* Giles were the only vectors of malaria in French West Africa, but in the dry season of 1949, *A. rufipes* (Gough) was found infected at Dori (Haute-Volta) where it formed 72·4 per cent. of the mosquitos taken in dwellings, whereas *A. funestus* and *A. gambiae* formed only 3·4 and 1·4 per cent. Malaria morbidity and infant mortality from malaria were high. Sporozoites were found in two and oöcysts in five of 127 females dissected. Three females of *A. rufipes* out of nine were also found infected with oöcysts or sporozoites in an area (Bobo-Dioulasso) where *A. gambiae* and *A. funestus* were very much more numerous in houses and both were infected to the extent of about 15 per cent. Only two other records of natural infection of *A. rufipes* in any part of West Africa are known [*R.A.E.*, B **22** 212; **37** 183].

Baltazard (M.), Mofidi (C.), Bahmanyar (M.), Seydian (B.) & Habibi (A.). **Sur la transmissibilité des spirochètes récurrents par le pou.**—*Bull. Soc. Path. exot.* **43** no. 3–4 pp. 176–186, 1 fig., 10 refs. Paris, 1950.

Baltazard (M.), Bahmanyar (M.), Habibi (A.), Mofidi (C.) & Seydian (B.). **Fièvres récurrentes humaines. Leur transmissibilité par le pou.**—*T. c.* no. 5–6 pp. 309–317, 1 graph, 3 refs. Paris, 1950.

In the first paper, experiments are described on the transmission of tick-borne species of *Spirochaeta* (*Borrelia*) to susceptible mammals or birds by inoculation of lice [*Pediculus humanus humanus* L.] that had fed

on infected ones. The results were positive with *S. microti*, *S. turicatae*, *S. merionesi*, *S. parkeri*, *S. anserina* (*gallinarum*) and *S. hispanica*, and negative with *S. persica*. Records of similar experiments cited from the literature show positive results with *S. duttoni*, *S. hermsi*, *S. crocidurae* and *S. novyi*, a negative result with *S. normandi* in a single test [*R.A.E.*, B **16** 2], varying results with *S. hispanica* and negative results with *S. persica*. Of all these spirochaetes, the last two are the only ones pathogenic for guineapigs or adult rabbits, and the experiments in general support the view that spirochaetes that are not pathogenic for these animals develop readily in lice whereas those that are develop in lice much less readily or not at all. These results are not taken to indicate a particular adaptability in certain species of spirochaetes, since the species that can develop in lice include those that normally show the greatest specificity with regard to their invertebrate hosts. The adaptability seems to be in the louse, which can occasionally become a vector of a disease that does not normally affect man and be the only vector that transmits it from man to man. It may even cause epidemics in this way, as it is known to do in the case of murine typhus [**40** 87].

In the second paper, an account is given of experiments in Iran in which it was shown that *S. microti* and *S. crocidurae* can be transmitted from man to man by lice as readily as can *S. recurrentis*. Most experimental transmissions were by subcutaneous inoculation of suspensions of large numbers of lice, but transmission was also effected by placing a suspension of material from one infected louse on the conjunctiva. Transmission among the human population by lice of spirochaetes widespread among rodents and *Ornithodoros* could, if it occurred in nature, explain the occurrence of epidemics of relapsing fever of the louse-borne type, the reservoir of which is unknown. However, under the conditions of the experiments, repeated passage from man to man through lice caused no modification of the spirochaetes towards the type of *S. recurrentis*.

DE TOLEDO (A. A.). **Experiências sôbre o combate ao berne por inseticidas.** [Experiments on the Control of *Dermatobia hominis* by Insecticides.] —*Biológico* **17** no. 7 pp. 123–129, 1 ref. São Paulo, 1951.

Tests were carried out in São Paulo in 1950–51 to compare the effectiveness of sprays of BHC and toxaphene and a BHC dust in protecting cattle from infestation by *Dermatobia hominis* (L.jr.). The treatments were applied fortnightly and the larvae were counted each month; the cattle were freed from infestation by the use of an ointment containing 4 per cent. γ BHC [*cf. R.A.E.*, B **41** 96] before the first treatment and after each count of larvae. About 3·5 pints spray or 1 oz. dust was applied per animal. The first series of tests was made during the dry season from July to October 1950, and the total numbers of larvae found per batch of 20 animals by the end of the four months were: 178 and 446 for sprays containing 1 per cent. of a 50 per cent. toxaphene emulsion concentrate and a 40 per cent. toxaphene wettable powder, respectively; 250 for a 0·5 per cent. spray of wettable BHC powder containing 12 per cent. γ isomer; 336 for a mixed spray containing 0·6 and 0·2 per cent. of the toxaphene and BHC powders; and 144 for the BHC powder in a dust containing 3 per cent. γ isomer. A dust has the advantage that it adheres more easily than a liquid to the infested parts, which become wet with exudate. The second series of tests was made in the rainy season, from November to April, the same treatments were applied, and the toxaphene emulsion spray and the BHC dust were also tested without the monthly treatment with the BHC

ointment. These two were again the most effective; they gave 91 and 84·8 per cent. reduction in the numbers of larvae, respectively, as compared with no treatment when the BHC ointment was used, and 72·8 and 84·8 per cent. when it was not.

[Chereshnev (N. A.).] Черешнев (Н. А.). **Biological Peculiarities of the Botfly** *Gastrophilus pecorum* **Fabr. (Diptera, Gastrophilidae).** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* (N.S.) **77** no. 4 pp. 765–768, 1 fig., 7 refs. Moscow, 1951.

The results are given of field and laboratory investigations in Kazakhstan in 1950–51 on the bionomics of *Gasterophilus pecorum* (F.) and the way in which horses and donkeys are infested by it. They showed that there is one generation a year. The full-fed third-instar larvae abandoned their hosts between 5th August and 5th September and pupated in the upper four-inch layer of the soil, the pupal stage lasting 12–21 days. The adults paired and oviposited on the day of emergence, and eggs were laid on the leaves and stems of plants, chiefly grasses, in the field and on any object in the laboratory [*cf. R.A.E.*, B **20** 135]. The adults were not attracted to horses or donkeys and lived for up to four days in the laboratory, in the course of which the females deposited totals of 1,298–2,425 eggs each in batches of 10–15. Their movements from place to place during the process indicated that they would distribute their eggs over considerable areas of a pasture or hay meadow. Embryonic development was completed in 5–8 days, and the eggs were then very resistant to adverse conditions; those exposed to the direct rays of the sun survived for a week, and eggs laid on 28th August contained active larvae in the following January in spite of fluctuations in the weather and temperatures as low as –17°C. [1·4°F.].

The eggs hatch when taken up by horses or donkeys with the grass and doubtless also when taken up with infested hay owing to their prolonged viability. Eggs placed in the mouths of animals hatched in 3–5 minutes, and experiments showed that hatching was stimulated by the saliva and the warmth. Newly hatched larvae placed on the mucous membrane of the lips, gums or tongue of a horse or donkey, penetrated into it in 3–5 minutes. Examinations of the digestive tracts of naturally or artificially infested horses showed that some of the first-instar larvae burrow into the mucous membrane of the lips, gums, cheeks, tongue and hard palate and mine towards the root of the tongue and the soft palate, while others are swallowed with the food and establish themselves in the walls of the pharynx, oesophagus and stomach. Large accumulations of larvae were frequently found in the soft palate and at the root of the tongue, where they remained for some 9–10 months, from autumn to August, and reached the third instar. Towards the end of the third instar, they moved from the mouth cavity to the stomach, where they became full-fed. After this they passed into the rectum and left the host. The numbers of larvae per infested animal varied greatly, being 10–250 in the mouth cavity and some 100–700 in the stomach in horses, and 5–100 in the mouth cavity in donkeys.

[Nel'zina (E. N.) & Romanova (V. P.).] Нельзина (Е. Н.) и Романова (В. П.). **The Method of Transmission of the Tularaemia Microbe** (*B. tularense*) **by Gamasid Mites.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* (N.S.) **78** no. 1 pp. 179–180, 12 refs. Moscow, 1951.

Investigations by various workers in the Soviet Union on the possible relation of Gamasid mites to tularaemia have shown that the bacteria can

be isolated from mites collected from the burrows of rodents [*R.A.E.*, B **23** 85] or on infected water-voles [*Arvicola terrestris*], that they persist in the mites for up to ten days at 18–24°C. [64·4–75·2°F.] or 15 days at 6–10°C. [42·8–50°F.], and that they can infect healthy rodents to which mites from infected ones are transferred. It was, however, thought possible that the rodents that acquired infection from the mites did so by eating them, and experiments in which this possibility was excluded were therefore carried out.

The mites used were females of *Haemolaelaps mohrae* Oudm., which attack many hosts, and they were infected by placing them on a rodent that was dying of tularaemia. They were removed from its carcass next day, and those that had engorged were kept in test-tubes at 4–10°C. [39·2–50°F.] for 6–8 days to allow them to complete the digestion of the blood. They were then transferred to a shorn patch on the back of a healthy mouse. The mouse had a collar of celluloid film that prevented it from dislodging the mites, and these were covered with a small cotton hood fixed with collodion to its skin. The mites were removed on the following day. Four mice were exposed in this way, and two became infected, though only one of the eight mites placed on one of them had engorged. It is concluded that Gamasids are active vectors of tularaemia, its transmission being connected with the process of sucking blood.

[Shoshina (M.).] Шошина (М.). **The Determination of a repeated gonotrophic Cycle in Sandflies.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* (N.S.) **78** no. 1 pp. 181–183, 1 fig., 3 refs. Moscow, 1951.

From a study of the relation between the state of the lubricating glands and the stage of the gonotrophic cycle in females of *Phlebotomus papatasi* Scop., *P. caucasicus* Marz. and *P. sergenti* Parr. [*cf. R.A.E.*, B **32** 50], the author distinguishes seven stages of development of the glands in the first gonotrophic cycle, corresponding to those of blood-digestion. The first stage occurs in the newly emerged females; the glands are only 0·4–0·5 mm. long and contain no secretion. As blood-digestion and ovarian development progress, the glands increase in length and relative width, reaching a maximum length of 0·8–1 mm. in the final (seventh) stage. Secretion appears in them at the fourth stage and fills them completely in the seventh stage. After the female has oviposited, the glands retain the size and shape they reached at the seventh stage. They contain no secretion or only its remains at the beginning of a new gonotrophic cycle, begin to produce it as the cycle progresses, and are filled at the end of it. Thus, if a female in any of the earlier stages of a gonotrophic cycle is found to have glands of the size and shape of the seventh stage it must have completed the first gonotrophic cycle.

Differentiation of females that have completed a gonotrophic cycle is of importance in studies of the relation of sandflies to cutaneous leishmaniasis, since they require a first feed to become infected with *Leishmania* [*tropica*] and a second to transmit it. The period required for it to reach the infective stage in the sandfly (some 3–8 days) is about the same as that required by the gonotrophic cycle, as both are affected by environmental factors, particularly temperature. Observations by various workers have shown that the gonotrophic cycle is completed in an average of 9 days at Erevan (south-western Armenia), 3–5 days at Stalinabad (western Tadzhikistan) and 5–8 days at Osh (western Kirghizia).

[Nel'zina (E. N.) & Barkov (I. P.).] Нельзина (Е. Н.) и Барков (И. П.). **The Carrying of the Microbe of Tularaemia** (*B. tularense*) **by certain Species of Gamasid Mites under natural Conditions.** [*In Russian.*] —*Dokl. Akad. Nauk SSSR* (N.S.) **78** no. 4 pp. 829–831, 4 refs. Moscow, 1951.

In investigations at Rostov-on-Don in 1949 on the importance of Gamasids as vectors of the bacteria of tularaemia in nature [*cf. R.A.E.*, B **41** 183], 3,863 of these mites were collected from water-voles (*Arvicola terrestris*) and grey voles (*Microtus arvalis*) between April and December and tested in batches for infection by the usual laboratory method. The bacteria were isolated from a batch of 22 examples of *Laelaps muris* (Ljungh) (*agilis* Koch) taken on *Arvicola* in November, and from four batches comprising a total of 360 examples of *Haemolaelaps mohrae* Oudm. taken in the nests of *Microtus* in October–November. These two mites were the most numerous of those identified and are both common. *L. muris* is restricted to *A. terrestris*, requires frequent blood-meals and is unable to survive for long in the absence of the host, the maximum survival period in a test-tube at 17–20°C. [62·6–68°F.] being 19 days. It is most numerous from October to May, while its host is below ground. It can thus act as a vector of tularaemia only among water-voles, and would do so chiefly in winter. *H. mohrae* infests numerous rodents, including house mice [*Mus musculus*], and is most numerous in spring-summer. After *L. muris*, it was the commonest mite on water-voles. It remains on its host only while feeding, however, and is mainly found in rodents' nests, in which it moults and oviposits. It survived without feeding for up to 65 days in a test-tube at 20–26°C. [68–78·8°F.]. In view of its host range, *H. mohrae* must be considered an important vector of tularaemia among rodents, particularly in spring and summer.

[Pavlovskiĭ (E. N.) & Skruinnik (A. N.).] Павловский (Е. Н.) и Скрынник (А. Н.). **Some biological Peculiarities of the Ticks** *Ornithodorus*— **Transmitters of the Tick-borne Relapsing Fever.** [*In Russian.*]— *Dokl. Akad. Nauk SSSR* (N.S.) **78** no. 5 pp. 1069–1072, 7 refs. Moscow, 1951.

The authors record the results of further observations in the Soviet Union [*cf. R.A.E.*, B **40** 213, etc.] on the length of life and resistance to starvation of *Ornithodoros tholozani* (Lab. & Mégn.) (*papillipes* (Bir.)), and on the persistence and transovarian transmission of the spirochaetes of relapsing fever in it.

When kept at 15–18°C. [59–64·4°F.] in flasks moistened with a drop of water once or twice a month and allowed to engorge once a year, 1,510 of 2,329 examples taken in Uzbekistan in 1944, 268 from 1,570 larvae that were reared in the laboratory and fed as larvae in 1939, and 38 males and 22 females of a batch of 3,069 ticks taken in the Pamirs in 1936 were all alive in 1951. One male taken as a nymph in 1934 in Turkmenia paired with a female in 1950, and the latter subsequently laid viable eggs. It is estimated that the total life of *O. tholozani* may reach 20–25 years.

A female has already been recorded as preserving relapsing-fever spirochaetes for 13 years [**33** 165]. In a further test, a male and a female kept in the laboratory since 1937 both infected guineapigs at every subsequent meal, including those taken in 1951. In investigations on transovarian transmission, 41 batches of F_1 ticks reared from infected females [*cf.* **40** 213] and 14 batches of F_2 ticks were fed separately on guineapigs. Only two F_1 batches and one F_2 batch infected the guineapigs on which they fed

as larvae, but 12 F_1 and six F_2 batches infected those on which they fed as first-stage nymphs. F_1 ticks that did not transmit the infection as larvae or first-stage nymphs did not transmit it subsequently, and those that transmitted it as nymphs usually continued to transmit for the rest of their lives. F_3 ticks did not transmit, but the ability of F_1 and F_2 ticks to infect man was shown in tests on patients suffering from progressive paralysis. The spirochaetes were preserved in this way from generation to generation for 14 years from the finding of the original infected individuals.

In tests on resistance to starvation, larvae survived without feeding for up to 15 months, though mortality became considerable after 6–7 months, nymphs in the first, second, third and fourth-fifth stages for 2, 4, 8 and 11 years, and adult males and females for 9 and 10 years, respectively. Of 742 examples kept without food since 1940, eight nymphs and one female were still living in 1950, and one nymph, taken in the Pamirs in 1936 and allowed to feed in 1937 and again in March 1940 was still alive in 1951, 11 years later. Ticks that had not fed for ten years were emaciated and moved with difficulty, so that starvation for this period is probably close to the limit. Repeated starvation is also possible. Thus, two nymphs and a female that fed after eight years without food, survived without feeding again for another three years, and a male and a nymph that had fed after 7½ years survived another 5½ years. Females produced viable progeny after three and five years without food [*cf.* **40** 214], and five nymphs that fed after ten years' starvation continued their development. Uninfected ticks acquired relapsing-fever spirochaetes when fed after being starved for 9–10 years and transmitted the spirochaetes at the following meals, and infected ones transmitted them after having been starved for seven years.

In tests with other ticks [*cf.* **40** 214], *O. verrucosus* Olen., Zas. & Fen. survived without food for three years, *O. tartakovskyi* Olen. for four, *O. canestrinii* Bir. for six, and *O. lahorensis* Neum. for eight.

Hurlbut (H. S.). **The Propagation of Japanese Encephalitis Virus in the Mosquito by parenteral Introduction and serial Passage.**—*Amer. J. trop. Med.* **31** no. 4 pp. 448–451, 6 refs. Baltimore, Md., 1951.

An account is given of investigations in which propagation of the virus of Japanese B encephalitis in *Culex pipiens fatigans* Wied. (*C. quinquefasciatus*, auct.) was demonstrated by parenteral injection and serial passage. Titration experiments indicated that the emulsified whole bodies of the mosquitos would give 50 per cent. mortality of mice if injected intracerebrally at dilutions ranging from $10^{-6 \cdot 5}$ to $10^{-8 \cdot 4}$. Virus could be demonstrated in appreciable amount 24 hours after injection into the mosquito and was present in a relatively high concentration after 48 hours. A concentration near to the maximum was reached on the third or fourth day, and it presumably then remained with very little change for as long as 17 days. Mosquitos into which the virus was injected parenterally transmitted it to suckling mice by bite after as little as 48 hours of incubation at 30°C. [86°F.].

Hayes jr. (W. J.), Ferguson (F. F.) & Cass (J. S.). **The Toxicology of Dieldrin and its Bearing on Field Use of the Compound.**—*Amer. J. trop. Med.* **31** no. 4 pp. 519–522, 2 graphs. Baltimore, Md., 1951.

In view of the promise shown by deposits of dieldrin against a variety of insects, the hazard involved to those who applied it was examined. Experiments with many kinds of laboratory animals indicated that one contamination of the skin with 100 cc. or more of a 25 per cent. solution might be

dangerous to a man if not washed off promptly, but minor daily contamination with the emulsified solutions used for spraying under field conditions might not. Technical powder was absorbed by the unabraded skin practically as readily as solutions in organic solvents. The symptoms of dieldrin poisoning are described. Barbiturates have shown some promise as antidotes.

In limited operational control experiments in various States, workmen received no apparent injury. It is concluded that dieldrin can be safely used in public health programmes by properly trained personnel in sprays to apply insecticide deposits outdoors.

Jensen (J. A.) & Fay (R. W.). **Tagging of Adult House Flies and Flesh Flies with Radioactive Phosphorus.**—*Amer. J. trop. Med.* **31** no. 4 pp. 523–530, 8 refs. Baltimore, Md., 1951.

The following is largely based on the author's summary. Adults of *Musca domestica* L., *Callitroga macellaria* (F.) and *Lucilia cuprina cuprina* (Wied.) (*Phaenicia pallescens* (Shann.)), the most prevalent flies in trap catches around dwellings, dumps, etc., in south-eastern Georgia, were marked with radioactive phosphorus by feeding them for 1–3 days on milk into which P^{32} had been incorporated. Rearing the larvae in media containing P^{32} gave only a low radioactivity to the resulting adults [*cf. R.A.E.*, B **39** 181; **40** 174]. Females of each species took up and retained more P^{32} than did the males on all the feeding routines. Females took up and retained appreciably more P^{32} when the feeding period was longer than one day, but males did not. *C. macellaria* attained the highest level of radioactivity and *M. domestica* the lowest. Adults 1–6 days old showed only minor differences in initial uptake of P^{32} with a one-day feeding period. When the concentration of P^{32} in the milk was varied from 0·5 to 4 microcuries per ml., the initial uptake of P^{32} was approximately proportional to the concentration. Flies retained their radioactivity longer if subsequently fed on 10 per cent. honey solution than if fed on milk. The decline may be correlated with the higher phosphorus content of the milk. Practical tests showed that flies marked with P^{32} can be detected in dead samples from trap catches or in living material at bait stations [*cf.* **40** 177]. The former method is the more effective.

Hawley (J. E.), Penner (L. R.), Wedberg (S. E.) & Kulp (W. L.). **The Role of the House Fly, *Musca domestica*, in the Multiplication of certain enteric Bacteria.**—*Amer. J. trop. Med.* **31** no. 5 pp. 572–582, 6 figs., 17 refs. Baltimore, Md., 1951.

Recent evidence has related the incidence of certain intestinal diseases to the prevalence of flies [*cf. R.A.E.*, B **39** 86; **41** 126], and many investigators believe that house-flies (*Musca domestica* L.) carry pathogenic organisms both internally and externally. Most earlier work on the subject, however, has failed to deal with individual flies, and the need for experiments of the type described in this paper was obvious. Reports containing the best evidence of dissemination of bacteria by *M. domestica* are reviewed, and reference is also made to papers seeming to show that the intestine of the fly is bactericidal or contains a bacteriophage active against human pathogens [**14** 172].

Larvae of a stock colony of *M. domestica* were reared in Ehrlenmeyer flasks, each connected by a U-tube with a similar flask containing sand. A means was provided of pumping fresh air continuously through the flasks.

Provided the air stream was maintained, the larvae remained in the rearing medium until they were ready to pupate. They would then migrate through the U-tube into the sand. If a steady flow of air was not maintained, they migrated prematurely and died. The pupae were collected from the sand and incubated in individual bottles so that the date of emergence of the flies could be recorded. Each fly required for experiment was lightly anaesthetised and put on its back on a block of paraffin wax attached to the end of a glass rod. The wax was then slightly warmed to fix the fly. Two types of apparatus for holding the blocks with the mounted flies are described. With one of them, the flies could be kept in a sterile environment and the excreta collected in a sterile medium (physiological saline). With the other, the excreta were collected on a non-nutrient agar. Mounted flies were kept alive satisfactorily by feeding twice daily, once on sterilised 0·5 molar sucrose solution and once on sterile skim milk. To study the normal flora, faecal cultures of 36 flies were examined 24 hours after the flies were mounted and again immediately after they died. Ten species of bacteria were isolated at the first examination. Most were types commonly present in soil and water. *Proteus morganii* was isolated from 28 of the flies and *Aerobacter aerogenes* from 20. Two other species were isolated three and four times, respectively, and the rest once. Only *P. morganii* and *A. aerogenes* were found after the death of the flies. They had persisted in all those in which they had been found originally.

In the controlled feeding experiments on multiplication of bacteria, known numbers of *Escherichia coli*, *Salmonella schottmülleri* and *Shigella dysenteriae* were administered to 36, 48 and 48 flies, respectively, 24 hours after they had been mounted. Flies that ingested less than 1,000 of the specified organisms in a single feeding did not pass them in their faeces, but as the numbers ingested increased, multiplication occurred within the flies, as was shown by the excretion of significantly greater numbers than were ingested. The excretion remained at a high level for at least six days. The death of many of the flies limited the length of the observation period. Controlled studies eliminated the possibility that the fly excreta, in themselves, might supply enough nutrients to allow the organisms to multiply.

Simpson (T. W.). **A Note on Filariasis among the Natives of Okinawa, with particular Reference to possible Transmission of** *Wuchereria bancrofti* **by** *Anopheles hyrcanus sinensis*.—*Amer. J. trop. Med.* **31** no. 5 pp. 614–616, 11 refs. Baltimore, Md., 1951.

Filariasis with nocturnal periodicity due to *Wuchereria bancrofti* is endemic in Okinawa; its incidence in the native population during April–July 1945 was found to range from about 10 to 30 per cent. and was generally higher in inhabitants of rural districts than in evacuees from relatively urban areas. It is commonly assumed that the chief vector is *Culex pipiens fatigans* Wied. (*C. quinquefasciatus*, auct.), the most prevalent mosquito known to be a good natural vector elsewhere. Other species present in Okinawa that have been cited as effective natural or experimental vectors in other regions include *Anopheles hyrcanus sinensis* Wied., *Aëdes togoi* (Theo.), *C. sinensis* Theo., *C. tritaeniorhynchus* Giles and *C. vishnui* Theo. *Anopheles hyrcanus sinensis*, for which nearby rice-fields flooded with rain-water provided numerous breeding places, was abundant in coastal areas where malaria (*Plasmodium vivax*) and Japanese B encephalitis began to spread rapidly among refugees living in overcrowded conditions during the summer of 1945. The females fed voraciously at night on man in the

almost complete absence of domestic animals. Dissection of 49 showed four to be infected with filarial larvae. Three contained larvae of 4–5 days' development, and the fourth a single mature larva in the proboscis. Of 180 concurrently dissected females of *C. p. fatigans*, 14 had filarial larvae.

Reeves (W. C.) & Rudnick (A.). **A Survey of the Mosquitoes of Guam in two Periods in 1948 and 1949 and its epidemiological Implications.** —*Amer. J. trop. Med.* **31** no. 5 pp. 633–658, 6 figs., 33 refs. Baltimore, Md., 1951.

Surveys of the mosquito fauna of Guam were carried out from 17th February to 9th March 1948 and from 2nd November 1948 to 17th January 1949, primarily with a view to determining the vectors of Japanese B encephalitis, an epidemic of which broke out there in December 1947. The findings are based on 2,261 larval collections, from which larvae and reared adults were identified and on 275 adult collections from human habitations, stable traps and light traps, from which 23,292 adults were identified. Laboratory tests for encephalitis viruses on 20,361 adults representing six species were negative, but the value of this result is limited as no epidemic was in progress at the time.

Aëdes aegypti (L.) was represented by a single adult taken during the first survey. It is therefore not possible to say that it was eradicated by the extensive control programme undertaken for the suppression of dengue [*R.A.E.*, B **41** 103], but it appears to be too scarce to be of importance as a disease vector. The other mosquitos taken comprised five species of *Aëdes*, three of *Culex* and *Anopheles subpictus indefinitus* (Ludl.). The last, like *Aëdes albopictus* Skuse, had not previously been found in Guam [*cf. loc. cit.*] and had probably been recently introduced. It is the first species of *Anopheles* to become established in the central Pacific area. It bred chiefly in ground pools. It is mainly zoophilous and an inefficient vector of malaria, and there is no reason for supposing that it transmits any disease in the area. *Aëdes albopictus* was common and had apparently replaced *A. aegypti*. It could transmit dengue if the disease was reintroduced and has transmitted Japanese B encephalitis experimentally [*cf.* **40** 163]. Larvae of *A. guamensis* Farner & Bohart were frequently collected in artificial containers, often near dwellings, and 21 females were taken feeding on man. *A. pandani* Stone [**41** 103] fed voraciously on man, horse and cow, and females engorged with human blood were often taken from the interior of dwellings. *A. vexans nocturnus* (Theo.), one of the principal ground-pool breeders [*cf.* **41** 103], was common and fed on a wide range of hosts, including man and domestic animals. The annual population peak appeared to correspond closely with the season during which the epidemic of Japanese B encephalitis occurred. *A. vexans* (Mg.) from Guam, presumably subsp. *nocturnus*, has been reported as a laboratory vector of the disease [**40** 163], and it would appear that there is reason to suspect it there, as a vector of any mosquito-borne virus disease of animals transmissible to man.

Filariasis of man is not endemic in Guam, but as many adults of *C. pipiens fatigans* Wied. (*quinquefasciatus*, auct.) were collected from dwellings, 89 per cent. of the 352 blood-engorged females tested had fed on man and the climate is apparently favourable for the transmission of filariasis, transmission by *C. p. fatigans* could probably establish the disease if human carriers of a nocturnal strain [of *Wuchereria bancrofti*] were introduced. *C. annulirostris marianae* Bohart & Ingram was found feeding

on man, cattle, horse and dog, and engorged females were taken from human dwellings. It was second in abundance to *C. p. fatigans* and bred for preference in ground pools. *C. annulirostris* Skuse (not this subspecies) and *C. p. fatigans* are both experimental vectors of Japanese B encephalitis [**40** 86]. The other two mosquitos taken were *C. litoralis* Bohart and *Aëdes oakleyi* Stone: they were not abundant and appeared unlikely to have any relation to human disease.

The distribution of the immature stages of the various species in breeding places of different types is considered in detail. It is concluded that most domestic pest species and potential vectors of disease come from man-made breeding places (domestic water receptacles and domestic and military refuse) and suggested that any control programme should be aimed at the detection and correction or elimination of these breeding-places. Control of breeding in ground pools, plants and coconut shells near thickly populated areas during and immediately after the rainy season would be an important supplementary measure.

Hoogstraal (H.) & Knight (K. L.). **Observations on *Eretmapodites silvestris conchobius* Edwards (Culicidae) in the Anglo-Egyptian Sudan.** —*Amer. J. trop. Med.* **31** no. 5 pp. 659–664, 3 figs., 13 refs. Baltimore, Md., 1951.

Eretmapodites silvestris Ingram & de Meillon represented by subsp. *conchobius* Edw., is recorded from the Anglo-Egyptian Sudan, where it was first found in July 1948 breeding in considerable numbers in leaf axils of *Sansevieria nilotica* in patches of vegetation around Torit in eastern Equatoria Province. The larva and pupa are described for the first time, and notes on its breeding and feeding habits are given from field observations. The females bite man fiercely. Mosquitos of the genus *Eretmapodites* are considered to be of potential importance as vectors of yellow fever [*R.A.E.*, B **16** 236], and the disease is endemic in the area [*cf.* **35** 105, etc.]. *Aëdes simpsoni* (Theo.), which is a known vector of yellow fever in other parts of Africa [**37** 150, etc.] and appears not to have been previously recorded from the south-eastern Sudan, was found at the same time as *E. s. conchobius*, breeding in smaller numbers around Torit.

Doucet (J.). **Les anophélinés de la région malgache.**—*Publ. Inst. Rech. sci. Tananarive* [3 +] 198 pp., 87 figs., 26 refs. Tananarive-Tsimbazaza, 1951.

This work is divided into two almost equal parts. The first is a systematic review of the Anophelines of Madagascar and includes descriptions of the adults, and immature stages if known, of some 20 species and varieties of *Anopheles* that occur there, together with keys to the eggs, larvae, pupae and female adults and notes on breeding places, habits and local distribution. The second part, on the control of malaria, includes brief notes on chemical prophylaxis, and accounts of the ways of obtaining protection from attack by Anophelines, the use of insecticides against the adults in houses, and the control of larvae by drainage and water management, the use of fish and of larvicides, and the destruction or modification of potential breeding places. Anti-malaria legislation in Madagascar and Indo-China is quoted in appendices. Throughout the book, the aim is to give information that is practical rather than original. The author acknowledges his indebtedness to Evans [*R.A.E.*, B **26** 182] and de Meillon [**36** 59] for

systematic information and descriptions of Anophelines, to Russell, West & Manwell [**35** 134] for information on control, and to Scharff [*cf.* **27** 126] for data on water management and drainage.

Lane (J.). **Synonymy of Neotropical Culicidae (Diptera).**—*Proc. ent. Soc. Wash.* **53** no. 6 pp. 333–336. Washington, D. C., 1951.

Examination of types in the collections of the British Museum and the United States National Museum has enabled the author to establish synonymy among a number of species of neotropical Culicidae. A list is given of 47 valid species with their synonyms. The only species of *Anopheles* in it is *A. mediopunctatus* (Theo.) of which *A. costalimai* Fonseca & Ramos [*R.A.E.*, B **35** 126] is considered a synonym, the genitalia of the type male of *costalimai* having characters intermediate between those by which *costalimai* and *mediopunctatus* were differentiated. In a supplementary note, *A. laneanus* Corrêa & Cerqueira [**38** 19] is considered a subspecies of *A. cruzi* Dyar & Knab, and the subgenus *Shannoniella* [**28** 220] is not considered distinct from *Arribalzagia*.

Bonne-Wepster (J.) & Swellengrebel (N.H.). **The Anopheline Mosquitoes of the Indo-Australian Region.**—504 pp., 179 figs., 22 maps, 8 pp. refs. Amsterdam, J. H. de Bussy, 1953.

Most of this work consists of a systematic review of the Anophelines of the Indo-Australian region (the Oriental and Australian Zoogeographical regions). Descriptions of the adults and larvae of the various species are given, together with data on the original descriptions and types and brief notes on bionomics, relation to disease and distribution. Keys to the females and larvae are included. In an introductory section, the characters used in classification are described and technique is discussed.

In the preface, some doubt is expressed as to the existence of reliable genetical barriers between the components of complexes. It is pointed out that the validity of these forms as species can never be proved or disproved by taxonomic [morphological] study but only by breeding and interbreeding. Nevertheless, taxonomy remains the basis of breeding experiments and until these are completed, it will remain the basis of malaria control. For this reason, sections on natural malaria infection and breeding habits have been kept brief to allow more space for taxonomic information.

Patel (T. B.) & Rodde [*i.e.* Rodda] (S. T.). **Use of D.D.T. as a Plague Control Measure in the Bombay State.**—*Indian med. Gaz.* **87** no. 5 pp. 217–221. Calcutta, 1952. **Erratum.**—*T. c.* no. 8 p. 377.

The effect of various DDT treatments against rat fleas on the incidence of plague in man was studied over a period of four years in 180 villages in Bombay State, in 106 of which cases of human plague had been reported. The treatments were indoor spraying of all houses and huts with 1 per cent. DDT in wettable-powder suspension or 3 per cent. in emulsified solution at about 65–75 mg. DDT per sq. ft.; a combination of such spraying with treatment of rat burrows by blowing 10 per cent. DDT powder into them; indoor spraying of houses in the infected part of the village only, combined with treatment of burrows; and treatment of the burrows alone. Records of numbers of cases of human plague indicated that the first three

treatments were highly effective and that treatment of the burrows was of doubtful value. The flea indices in some of the sprayed villages was reduced to below the critical level of one in about a week and remained low for three months or more.

It is concluded that spraying the interior of houses with DDT controls transmission of plague to man within 7–10 days if thoroughly done. The only measure carried out in addition to DDT treatment was a single-dose mass inoculation of about 40 per cent. of the population with vaccine. Dusting of burrows during epidemics and rat destruction during or between them were shown to be unnecessary. Rat destruction after an epizootic is considered harmful as the surviving rats are resistant to plague.

Weyer (F.). **Die Beziehungen des Q-Fieber-Erregers** (*Rickettsia burneti*) **zu Arthropoden.** [The Relationship of the causal Agent of Q Fever (*R. burneti*) to Arthropods.]—*Z. Tropenmed. u. Parasit.* **4** pt. 3 pp. 344–382, 15 figs., 2 pp. refs. Stuttgart, 1953. (With a Summary in English.)

An account is given of further experiments on the ability of arthropods to serve as vectors of *Rickettsia burneti* [*cf. R.A.E.*, B **39** 107]. Lice (*Pediculus humanus humanus* L.) were infected by injection of infected mouse spleen into the body cavity, the rickettsiae becoming visible in the body fluid after three days, and by injection of body fluid from infected lice into the body cavity or rectum. The rickettsiae were observed in stomach smears 14–26 days after rectal injection and in the faeces, and a strain derived from stomach smears was maintained through five passages by this means. The rickettsiae developed both intra- and extracellularly in the stomach and occurred in clumps, but were not found in the fore- or hind-gut or in the Malpighian tubes. Some penetrated the epithelium of the stomach and entered the body cavity, shortening the life of the lice, and some of these later developed intracellularly in the hypodermis, fat body and ovarial ampulla, though the eggs were not infected, while others entered the stomach cells from the body cavity.

Leptopsylla segnis (Schönh.), *Nosopsyllus fasciatus* (Bosc) and, in one case, *Xenopsylla cheopis* (Roths.) were tested by feeding on infected mice, and infection was demonstrated in two of four tests with *Leptopsylla* and one of four with *Nosopsyllus*. Fleas are thus not very susceptible hosts, though the rickettsiae appeared to find favourable conditions in their body cavity. Five similar tests with *Cimex lectularius* L. all gave positive results, and the faeces of the bugs were infective. *Triatoma infestans* (Klug) was infected by injection of mouse spleen into the body cavity, and older nymphs of *Rhodnius prolixus* Stål by feeding on an infected mouse, the excreta becoming infective in the latter case. Positive results were also obtained when the rickettsiae were injected into larvae of *Tenebrio molitor* L. through the intersegmental skin of the abdominal segments, and multiplication was so rapid as to kill some of the larvae, though others pupated normally.

Ornithodoros moubata (Murr.) was infected by injection through the anal opening into the rectal vesicle, which is not connected anatomically with the hind-gut, so that the liquid penetrates directly into the body cavity, and by feeding on infected mice. The rickettsiae multiplied in the gut and in various organs, including the salivary glands and coxal organs, were transmitted to the following generation after infection by either method, and were excreted in saliva, coxal fluid and urine. Infection persisted in the ticks for several years, so that these arthropods are useful for maintaining strains; they could also be used for diagnosis of the disease.

Baltazard (M.), Bahmanyar (M.) & Mofidi (C.). *Ornithodorus erraticus* **et fièvres récurrentes.**—*Bull. Soc. Path. exot.* **43** no. 9–10 pp. 595–601, 17 refs. Paris, 1950.

Data are given to show that *Ornithodoros erraticus* (Lucas) is represented by a small form in French West Africa, southern Morocco, the Moroccan Sahara and Persia, whereas the large or type form is known only from Spain and the northern parts of Morocco, Tunisia and Algeria. The record of the species in Egypt [*R.A.E.*, B **3** 47] is thought to need verification, and it is not known which form is present in Kenya [*cf.* **41** 9]. The small form was named *O. erraticus* var. *sonrai* by Sautet & Witkowski [**35** 45, 59], but it is more than probable that it is identical with *O. tartakovskyi* Olen. [**20** 24].

The only spirochaete with which the large form has been found infected in nature is *Spirochaeta hispanica*, and the known distribution of the tick corresponds exactly with that of the relapsing fever caused by this spirochaete. On the other hand, the small form has been found infected only with a spirochaete of rodents and insectivora that was named *S. crocidurae* in Senegal [**5** 98] and subsequently *S. merionesi* in Morocco and *S. microti* in Persia [*cf.* **41** 9]. This spirochaete is distinguishable from *S. hispanica* by its lack of pathogenicity for guineapigs and adult rabbits and from *S. duttoni* by differences in pathogenicity for man and monkeys. Accounts are given of experiments on the transmission of *microti*, *crocidurae* and *merionesi* strains by the large form and of *S. hispanica* by the small form. They indicated a high degree of specificity in each form for the spirochaete that it transmits in nature [*cf.* also **35** 59]. Though ticks of each form could on occasion transmit the spirochaetes of the other, particularly when they received their infecting feed as first-stage nymphs, it appeared that they would not be able to ensure their survival in nature. The differences between the large and small forms of *O. erraticus* are considered to warrant specific status for each.

Harrison (J. L.) & Audy (J. R.). **Hosts of the Mite Vector of Scrub Typhus. I. A Check-list of the recorded Hosts.**—*Ann. trop. Med. Parasit.* **45** no. 3–4 pp. 171–185, 47 refs. Liverpool, 1951. **II. An Analysis of the List of recorded Hosts.**—*T. c.* pp. 186–194, 2 maps, 23 refs.

In the first part of this paper, a list is given of all the mammals and birds that have been recorded as hosts of *Trombicula akamushi* (Brumpt) and *T. deliensis* Walch, the recognised vectors of tsutsugamushi disease, which the authors consider for the purpose of this work as two subspecies of *T. akamushi sens. lat.* [*R.A.E.*, B **38** 190–191; **41** 6]. After the name of each host are given the name or names under which it has been recorded, the subspecies of mite found infesting it, the country or locality, and the reference. The hosts that are regarded as important are indicated. A second list comprises the mammals from which *Rickettsia orientalis* (*tsutsugamushi*) has been recovered. Again, the name or names under which the animal has been recorded, the place, and the reference are given for each.

The influence of the hosts on the distribution of the mites is discussed. It is presumed that "mite-islands" [*cf.* **41** 7] are patches of soil that provide suitable conditions for adult mites and to which full-fed larvae are continually returned by hosts with a short range. Larvae picked up by long-ranged hosts are likely to be shed away from the mite-island and either fall on unsuitable soil or be given uncertain opportunities of starting new colonies. Thus, conditions are most favourable for mite survival when

(1463) Wt. P9/3884 1/54 E.P. Ltd. Gp. 566. [B]

there is a preponderance of short-ranged hosts to perpetuate the colony and some long-ranged ones to enable fresh colonies to be formed. Mite-islands in which some of the larvae are congenitally infected with *R. orientalis* are termed " typhus-islands ". Rickettsiae can be recovered from the tissues of some mammals in endemic areas for periods varying from a few days to several months, but it is probable that others may be so resistant or so susceptible to infection as to be defective as potential reservoirs. Though the mite is the primary reservoir of the rickettsiae, there are indications that congenital transmission is not fully efficient. It is assumed that the mite larvae can be infected to an unknown degree by feeding on suitable infected mammals and that the resulting infection can be passed congenitally to subsequent generations. If infection from hosts provides a significant proportion of mite infections, typhus-islands will be most favoured where mite-colonies are based on short-ranged hosts that harbour infection for a considerable period. Suggestions are made for the more satisfactory presentation of host data in the future.

The data recorded in the first part of the paper form the basis of the analysis and discussion that make up the second part, of which the following is substantially the authors' summary. Of the 87 hosts recorded for *T. akamushi sens. lat.*, 32 are Murids and 11 are other rodents. The principal host is clearly *Rattus rattus* in various field-dwelling forms. The establishment of a heavily infested mite-island depends primarily on the populous colonies of forms of *R. rattus* in scrub, supported or even occasionally replaced by a few other species of rodent, insectivore, rat-like marsupial or bird. Other species of *Rattus* in Australia and the Pacific and voles and field-mice (*Microtus*, *Apodemus*) in Japan support the vector beyond the present range of field forms of *R. rattus*. Yet other mammalian and avian hosts of longer range may effect a wide dispersal of the vector by picking up large numbers of larvae from established mite-islands.

The status and distribution of both the genus and the subgenus *Rattus* are discussed. It appears that the centre of dispersal of *R. rattus* is in Malaysia, and it is considered that the greatest impulse to the evolution of this species (and of certain other members of the subgenus *Rattus*) has been given by the conditions created by man following his removal of the forest canopy and his growing of foodstuffs. The close association of *R. rattus*, *T. akamushi sens. lat.* and *Rickettsia orientalis* appears to be a secondary feature foreign to virgin forest conditions, and support is given to the view that the endemic disease is largely a man-made exacerbation of an enzootic jungle-tsutsugamushi infection of unknown extent.

Lavoipierre (M.) & Griffiths (R. B.). **A preliminary Note on a new Species of *Cnemidocoptes* (Acarina) causing Scaly Leg in a Budgerigar (*Melopsittacus undulatus*) in Great Britain.**—*Ann. trop. Med. Parasit.* **45** no. 3–4 pp. 253–254, 1 pl., 2 refs. Liverpool, 1951.

For some time, scaly leg has been known to occur in birds other than the domestic fowl, and it has usually been ascribed to *Cnemidocoptes mutans* (Rob. & Lanq.). However, examination of mites causing scaly leg in a budgerigar (*Melopsittacus undulatus*) led the authors to conclude that they represented a closely allied species, which is here designated *C. pilae* sp. n. Characters distinguishing the two species are described. V. R. Kaschula in South Africa has recently described a condition in canaries that he designates " tassle foot "; it is similar to the scaly leg caused by *C. mutans* in fowls but affects the pads of the feet and not the shanks. In the case of the budgerigar, both the shanks and the pads were affected. From a

photomicrograph accompanying Kaschula's paper, it seems possible that the mite was *C. pilae*. The authors state that *C. pilae* is the third species of *Cnemidocoptes* to be reported as causing scaly leg in birds, the second being *C. jamaicensis* Turk, which was recently described from a golden thrush (*Turdus aurantiacus*) in Jamaica [*cf.* also *R.A.E.*, B **21** 261]. It is thought that a careful study should be made of records of *C. mutans* from birds other than fowls since additional species of *Cnemidocoptes* may exist and the supposition that small wild birds act as a reservoir of *C. mutans* may be erroneous.

Radeleff (R. D.), Claborn (H. V.), Wells (R. W.) & Nickerson (W. J.). **Effects on Beef Cattle of prolonged Treatment with a DDT Spray.** —*Vet. Med.* **47** no. 3 pp. 94–96, 1 fig., 4 refs. Chicago, Ill., 1952.

In Texas, 12 Hereford cattle, 10–15 months old at the beginning of the experiment, were sprayed 31 times at fortnightly intervals with 0·5 per cent. DDT in emulsified solution to determine the toxic effect on cattle, if any, of prolonged repeated external exposure to DDT. Six of the animals had had little previous exposure to DDT, but six had been sprayed five times at intervals of three weeks before the experiment began and had previously been treated an unknown number of times on the ranches from which they were bought.

No ill effects from the treatment were observed clinically, at autopsy, or by histological study. Chemical analyses showed an average of a little less than 90 parts per million DDT in the fat of the cattle at the end of the experiment. Three treatments earlier, there was an average of 88 p.p.m. in the group that received 31 sprayings in all, which had 0·1 p.p.m. before the experiment began, and 84 p.p.m. in the group that received 36 sprayings in all, which had had 45 p.p.m. before the 31 experimental treatments began. Two steers of the latter group had 68 and 75 p.p.m. DDT in the fat, respectively, before the experiment began, but reached only 87 and 81 p.p.m. after 28 further treatments. It is concluded that the amount of DDT stored in the fat does not rise above about 90 p.p.m. There was practically no storage of DDT in edible tissue other than fat and marrow.

Norris (K. R.), Roulston (W. J.) & Snowball (G. J.). **Observations on the Control of the Cattle Tick with Preparations of DDT and Benzene Hexachloride (BHC) in Dips.**—*Aust. J. agric. Res.* **1** no. 2 pp. 165–177, 4 graphs, 7 refs. Melbourne, 1950.

Details are given of experiments with dips against *Boophilus annulatus microplus* (Can.) on cattle in Queensland carried out in 1947–48. The main results have been noticed from an annual report [*R.A.E.*, B **39** 29], but it appears that the BHC dip there stated to have contained 0·25 per cent. γ isomer in fact contained only 0·025 per cent. An increase in concentration to 0·05 per cent. prevented the loss of efficiency of the dip that had occurred when it was used continuously [*loc. cit.*], but the protection from reinfestation afforded by either concentration of BHC was not so lasting as that previously obtained with a colloidal DDT preparation [Rucide] by Hitchcock & Mackerras [**36** 104–105]. The results of analyses are given to illustrate the concentrations maintained during dippings and the rates of dispersion and settling, when the DDT dispersible powder and DDT and BHC dispersible pastes were used.

Waterhouse (D. F.) & Scott (M. T.). **Insectary Tests with Insecticides to protect Sheep against Body Strike.**—*Aust. J. agric. Res.* **1** no. 4 pp. 440–455, 8 figs., 22 refs. Melbourne, 1950.

The following is mainly based on the authors' summary of this account of tests in Australia, some of the results of which have already been noticed [*R.A.E.*, B **36** 118; **39** 30]. Areas on the backs of sheep were sprayed with several insecticides, and a comparison was made of the degrees and lengths of protection thus provided against oviposition by *Lucilia cuprina* (Wied.), and in one experiment, against strike (establishment of the larvae) when the sheep were exposed to a dense population of flies in an insectary. Indole plugs were tied into the fleece to provide conditions suitable for oviposition.

Under these conditions, DDT gave better protection against oviposition than other insecticides. In 2 per cent. concentration, it gave excellent protection for 6–8 weeks; in 1 per cent. concentration, it gave shorter though still valuable protection. A noticeable feature of the DDT treatments was that they afforded long partial protection after some oviposition was permitted, an effect that was not so marked with other insecticides. Crude BHC preparations gave valuable protection when applied at 0·5 per cent. γ isomer. Intermittent artificial rain, amounting to 17 ins., did not affect the protection afforded by 1 per cent. DDT or 0·5 per cent. γ BHC over a 64-day period. Chlordane gave some protection, but it was less effective than DDT, and toxaphene (chlorinated camphene) did not give useful protection.

In a test simulating natural conditions in which sheep were repeatedly exposed to fly attack and the fleece was kept moist with artificial rain to provide suitable conditions for larvae to develop, both 1 per cent. DDT and 0·05 per cent. γ BHC gave a high degree of protection from strike for 54 days [*cf.* **41** 65]. The cumulative percentages of the sheep treated with DDT and (in brackets) BHC that had strikes after 33, 54, 67 and 77 days were 0 (8), 8 (25), 33 (42) and 50 (92). Eggs were often deposited on the treated sheep, and larvae hatched and died, before strike occurred. This lack of strike must have been due to the presence of the insecticides in the fleece, as conditions were otherwise favourable. This type of protection was particularly noticeable among BHC-treated sheep, which often received many more egg batches than those treated with DDT.

With applications of 2 and 10 per cent. respectively, fogging was not an effective method of applying BHC or DDT for the prevention of body strike.

In vitro tests indicated that none of the insecticides was ovicidal. However, BHC was extremely toxic to larvae, the vapour killing them rapidly even when contact with the solid material was prevented. None of the other insecticides had a fumigant action, although they were often lethal on contact in high concentrations. It appeared that important protection was conferred by DDT through an inhibition of one of the early stages in the chain of reflexes leading to oviposition.

Scott (M. T.). **Observations on the Bionomics of** *Linognathus pedalis*.—*Aust. J. agric. Res.* **1** no. 4 pp. 465–470, 2 figs., 7 refs. Melbourne, 1950.

Linognathus pedalis (Osb.) is widespread in Australia, having been recorded from all states, including Tasmania. Observations on artificially

infested lambs in the laboratory showed that its life-cycle could be completed in a minimum of 43 days, including 17 days for the egg stage, seven for each of the three nymphal instars and five for the preoviposition period. Females laid about one egg per day. Only minimum periods could be accurately established by the method of observation, but it appeared that all nymphs would usually complete an instar within 24–48 hours of the minimum. The incubation period was 13–14 days at 35°C. [95°F.] and 12–13 days at 36·5°C. [97·7°F.]. Eggs did not hatch at 18–20°C. [64·4–68°F.]. Infestation is acquired by direct contact with infested sheep, and it was shown experimentally that lambs can acquire infestation from pastures at least 48 hours after the removal of infested sheep. At a relative humidity of 50 per cent., lice survived for 18 days off the host at 0–4°C. [32–39·2°F.] and 18–20°C. and for five days at 30°C. [86°F.].

Observations on an infested flock in New South Wales in 1947–48 showed that there was a pronounced seasonal fluctuation in populations, which were highest from July to November and lowest from December to March. Sheep under a year old were more heavily infested than older ones, and lambs sometimes became infested shortly after birth.

DE TOLEDO (A. A.). **Nocividade das chuvas ao efeito dos inseticidas sôbre o berne.** [The detrimental Effect of the rainy Season on the Effectiveness of Insecticides against *Dermatobia hominis*.]—*Biológico* **18** no. 4 pp. 57–61, 1 ref. São Paulo, 1952.

Further experiments on the control of *Dermatobia hominis* (L. jr.) on cattle in São Paulo [*R.A.E.*, B **41** 182] were carried out during four months of the rainy season in 1951–52. Dusts containing 3 per cent. γ BHC as lindane or in technical BHC and sprays containing 0·025 per cent. γ BHC or 0·5 per cent. toxaphene as emulsified solutions were applied fortnightly to batches of ten cattle at rates of 1 oz. dust or 3·5 pints spray per animal. They gave 66·7, 61·4, 75·4 and 73·7 per cent. control, respectively, as estimated from the total numbers of larvae found in four monthly counts on treated and untreated animals when the treated cattle were freed from infestation after each count by applications of a BHC ointment; and the two dusts gave 65·4 and 62·7 per cent. control on cattle on which the ointment was not used. The total number of larvae on the ten untreated animals was 1,399.

Insects.—*Yearb. U.S. Dep. Agric. 1952* xviii + 780 pp., 80 pls. (72 col.), text illus., refs. Washington, D.C. 1952. Price $2.50.

The successive yearbooks of the U.S. Department of Agriculture have been devoted to surveys of developments in agricultural science, and the subject of this one is economic entomology. It contains 110 articles by various contributors and is noticed as a whole elsewhere [*R.A.E.*, A **41** 425]. There are four articles on the principal insects, ticks and mites injurious to livestock in the United States, and six, not restricted to that country, on household insects, mosquitos and the control of insects affecting man, and on arthropods as vectors of diseases of man and livestock and as intermediate hosts of parasitic worms. A series of some 20 articles on the nature and preparation of insecticides, methods of applying them and the risks involved in their use includes one on their toxicity to livestock and is followed by three on the development of resistance to them in insects, particularly house-flies [*Musca domestica* L.] and mosquitos.

The Peet-Grady Method. Official Method of the Chemical Specialties Manufacturers Association for evaluating liquid Household Insecticides, 1952 Revision.—*Soap & sanit. Chem.* Blue Book 1952 pp. 255–258. New York, N. Y., 1952. **Latest Revision.**—*Op. cit.* Blue Book 1953 pp. 223–226. 1953.

These descriptions of the Peet-Grady method of testing sprays against the house-fly [*Musca domestica* L.], which are virtually identical, are a slightly revised version of one already noticed [*R.A.E.*, B **37** 89]. In them, it is stated that the flies for test should be not less than three nor more than six days old, but not that they should have an average age of four days, and that the food for adult flies must consist of 5 per cent. spray dried, non-fat milk solids and 2 per cent. granulated sugar thoroughly dispersed in water. Roller dried or caked milk solids are unsuitable, as they settle out of suspension within a few hours.

Gasser (R.). **Über ein neues Insektizid mit breitem Wirkungsspektrum.** [On a new Insecticide with a wide Range of Effectiveness.]—*Z. Naturf.* **8b** pt. 5 pp. 225–232, refs. Tübingen, 1953. (With a Summary in English.)

Investigations in Switzerland on the development of materials toxic to a wide range of insects and other arthropods but relatively harmless to mammals resulted in the production of O,O-diethyl O-(2-isopropyl-4-methyl-pyrimidyl(6)) thiophosphate, referred to as Diazinon or G 24 480. It is a colourless liquid boiling at 83–84°C., with a density of 1·116–1·118 and a solubility of 0·004 per cent. in water at 20°C., is miscible with ether, alcohol, benzene and other hydrocarbon solvents, and is more stable in alkaline than in acid or neutral media. Its vapour pressure is about five times that of parathion. The technical product contains about 95 per cent. active ingredient. In tests of acute oral toxicity to laboratory animals, the median lethal doses of Diazinon for rats and mice in cu. mm. per kg. body weight were 235 and 96 in gum arabic, 220 and 70 in a 20 per cent. emulsifiable solution (G 24 525), and 712·5 and 122·5 in a 25 per cent. spray powder (G 24 939). Tests of chronic toxicity showed that the average lengths of life of male and female rats receiving daily doses of 50 cu. mm. Diazinon per kg. body weight six days a week in the emulsifiable solution were 36 and 85 days, respectively, and in a similar test with rats receiving 10 cu. mm. per kg. per day, the figures were 250 and 89 for Diazinon and 0·4 and 5·4 for parathion. The mode of action and symptoms of poisoning in insects resembled those of parathion, except that Diazinon was more rapid in action. Both it and two further compounds, diethyl 3-methyl-pyrazolyl(5) phosphate (Pyrazoxon) and O,O-diethyl O-(-3-methyl pyrazolyl (5)) thiophosphate (Pyrazothion) were more effective than parathion in inhibiting cholinesterase from human red blood corpuscles and pseudo-cholinesterase from human plasma.

The toxicity of Diazinon to arthropods is mainly by contact, though it also has some stomach and fumigant effect. It is not toxic to nematodes. In tests on the contact action of deposits on glass, the lowest amounts per 100 sq. cm. that gave complete mortality were 0·001 mg. for *Musca domestica* L. and *Cimex lectularius* L., 0·01 mg. for *Blattella* (*Phyllodromia*) *germanica* (L.), 0·1 mg. for larvae of *M. domestica* and 1 mg. for *Periplaneta americana* (L.) and *Argas reflexus* (F.). Dilutions in water of 0·2 part per million were toxic to first-instar *Culex* larvae. Although in deposits on glass surfaces Diazinon was superior to DDT against *Aëdes aegypti* (L.), *Culex pipiens molestus* Forsk. and *Anopheles stephensi* List. for the first

14 days, it was much inferior in duration of effectiveness. It was more rapid in action than DDT against *Pediculus humanus humanus* L. (*P. h. corporis* Deg.) and *C. lectularius* and about equal to γ BHC or parathion against *A. reflexus* and *Ornithodoros moubata* (Murr.). It was used with success against flies, particularly *M. domestica* and *Stomoxys calcitrans* (L.), in houses and animal quarters in the Valais in 1951–52, and spray deposits remained effective for 4–6 weeks against strains of *M. domestica* that had developed resistance to DDT, BHC, chlordane and dieldrin. Diazinon also proved toxic to many pests of plants and stored products [*cf. R.A.E.*, A **41** 399].

Wolfinsohn (M.). **The Influence of the Water Content of the Medium on the Accumulation of Larvae and Pupae of the House-fly.**—*Bull. Res. Coun. Israel* **1** no. 1–2 pp. 166–168. Jerusalem, 1951.

As it had been observed that larvae of the house-fly [*Musca domestica* L.] that were being reared in a mixture of bran, straw and water in a sloping container, accumulated before pupation in the higher (and consequently drier) end, the phenomenon was examined more thoroughly. About 10 lb. of a 1 : 1 mixture of straw and bran was put into each of three containers and moistened with 2·66, 3·33 or 4 gals. water; 3 cc. of eggs were spread on the surface of the medium in each. The containers were 55 ins. long and inclined so that one end was 2 ins. higher than the other. They were kept at 28°C. [82·4°F.], and natural evaporation was allowed. After six days, the medium was removed from each container in six equal sections from the higher end to the lower end and examined for pupae. About half were in the highest section, and nearly all in the highest three. The proportion in the lower sections fell as the amount of water originally put in the container increased. Migration of the larvae to the drier medium began when they were three days old. In an experiment in which larvae could migrate from one section to another of a container in which water formed 0, 44·1, 61·2, 70·3, 76 and 80 per cent. by weight of the original composition of the medium, the remainder being straw and bran, they were found to prefer to pupate in the second section, the moisture content of which had fallen to about 26 per cent. when pupation occurred.

[Zhovtuii (I. F.).] Жовтый (И. Ф.). **The Number of Generations and the Duration of the Cycle of Development of *Musca domestica* L. under Conditions of Baraba (western Siberia).** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* (N.S.) **80** no. 3 pp. 477–480, 2 figs., 8 refs. Moscow, 1951.

Laboratory observations on the effects of temperature and breeding medium on the life-cycle of *Musca domestica* L. under the conditions of south-western Siberia were carried out in the Province of Novosibirsk in 1946 and 1947, the larvae being reared in cow, horse or pig dung or in human faeces, in all of which they commonly develop under natural conditions. The flies are active in the open for a period of some 120 days during May–September, beginning when the average temperature of the air outdoors remains above 10°C. [50°F.].

The sums of temperature required for development were calculated on the basis that the threshold is 10°C., and are given below in day-degrees centigrade [with the approximate Fahrenheit equivalents in brackets]. They were 102·9 [185] for the preoviposition period, and averaged 106·5 [192] for the egg and larval stages together, and 108·7 [196] for the pupal stage.

The figures for the egg-larval and pupal stages, however, varied according to the medium in which the larvae were reared, being 131·4 [237] and 109·4 [197] with cow dung, 109·3 [197] and 118·4 [213] with horse dung, 91·7 [165] and 102 [184] with pig dung, and 94·3 [170] and 93·2 [168] with human faeces. The differences in rate of development at the same temperature in the different media are attributed to differences in the physical and chemical properties of the latter. Successive generations were reared in the various media in 1946, when the total sum of effective temperatures was 662·7 [1,193], and 1947 when it was 803·7 [1,447]. The third generation was in the larval stage at the onset of winter in all media in 1946, but third-generation pupae were obtained from cow and horse dung, and third-generation adults from pig dung and faeces in 1947.

Hopla (C. E.). **Experimental Transmission of Tularemia by the Tropical Rat Mite.**—*Amer. J. trop. Med.* **31** no. 6 pp. 768–783, 5 figs., 14 refs. Baltimore, Md., 1951.

Bdellonyssus bacoti (Hirst) and mice were used in a quantitative study of certain aspects of the relationship between mites and tularaemia [*cf.* *R.A.E.*, B **41** 185, etc.]. The equipment and technique employed are described. The mites acquired infection by feeding and were shown by injection to retain an infection acquired when they were protonymphs, throughout the subsequent stages. The infection was retained throughout the life of the mites without significant reduction, despite several feedings on susceptible or recovered mice or prolonged periods of fasting. In 21·5 per cent. of cases examined, infected mites transmitted the infection to their progeny. The reason for the failure of most to pass the infection to the next generation when some did so is not known. Mites failed to produce an infection in normal mice by biting, though 200 were used in the tests and 84·5 per cent. of them were infected [*cf.* **41** 184], but infection resulted when mites were crushed orally by the mice. Mice often attempted to free their fur of mites by biting. A colony of mites that had fed on infected mice continued to infect the successive healthy mice introduced to it for a period of 18 months, at the end of which time 65 of 100 mites removed after fresh mice had been in the cage for only 48 hours proved to be infected. Titrations in mice indicated that mite passage neither decreased nor increased the virulence of organisms.

Laird (M.). **Insects collected from Aircraft arriving in New Zealand from Abroad.**—*Zool. Publ. Vict. Univ. N.Z.* no. 11, 30 pp., 53 refs. Wellington, N.Z., 1951.

The first paragraph of the following is virtually the author's summary.

The searching of 246 aircraft of seven military and civilian types on their arrival in New Zealand revealed that 88 (36 per cent.) had insect stowaways. A total of 548 insects collected included representatives of 56 families and ten orders, and nine spiders were also discovered. House-flies (*Musca domestica* L.) comprised more than a third of the total catch, 190 of these being collected on 46 separate occasions. Other insects of health significance included 29 blowflies (in 19 aircraft), 28 mosquitos (in 16 aircraft), 14 cockroaches (in 7 aircraft), and 2 fleas (in 1 aircraft). Actual or potential economic pests included numerous beetles, wasps, flies and moths. Among these were species already established in, and native to, New Zealand, a fact suggesting that insects might be exported from the country as well as imported into it. Records are given of the carriage of adult insects and

the eggs and larvae of moths on the exterior of aircraft fuselages. Aircraft and airport insect control are discussed, with particular reference to measures enforced at Whenuapai Airport by the Medical Branch of the Royal New Zealand Air Force, on behalf of the New Zealand Health Department.

All aircraft arriving at Whenuapai Airport from overseas are boarded by an orderly, who sprays them throughout by means of an aerosol " bomb ". The doors and windows of the aircraft then remain closed for five minutes, to ensure that the aerosol mist is not dispersed prematurely, before disembarkation and unloading takes place. Before boarding the aircraft, the orderly directs spray into the wheel cavities, and following disembarkation he also sprays any external baggage compartments and inspects the exterior of the fuselage to see if any insect nests or egg masses are present. In addition, he thoroughly searches the aircraft for insect remains, which are forwarded to Air Department for examination.

As a precaution against the breeding of mosquitos that might escape from the aircraft, all actual or potential mosquito breeding places within the bounds of the RNZAF Station, Whenuapai, are regularly treated with DDT larvicides and specimens of any batches of mosquito larvae found are forwarded to Air Department.

Wanson (M.). **Contribution à l'étude de l'onchocercose africaine humaine (problèmes de prophylaxie à Léopoldville).**—*Ann. Soc. belge Méd. trop.* **30** no. 4 pp. 667–863, 60 pls., 1 fldg. map, 2 graphs (1 fldg.), 11 pp. refs. Brussels, 1950.

Lists are given of 48 species of *Simulium* known in the Belgian Congo and the ten found in the district of Leopoldville [*cf. R.A.E.*, B **33** 1] (of which five and two, respectively, are represented by two varieties), and their local distribution and brief notes on their habits, if known, form the subject of an appendix. Variations in feeding habits within a species [*cf.* **41** 29] are briefly discussed. The only species that attack man readily near Leopoldville are *S. damnosum* Theo., *S. albivirgulatum* Wanson & Henrard and *S. faini* Wanson. A comprehensive account of the biology of the larvae and adults of the first [*cf.* **36** 146–148] including the gonotrophic cycle [**41** 13], is followed by brief notes on the bionomics of the other two, which resemble one another in their habits.

The remainder of the paper occupies about a hundred pages and contains chapters on the transmission of *Onchocerca volvulus*; its pathogenic effects in man; observations on the distribution and intensity of infection by it in the Leopoldville focus, with brief notes on other foci in the Belgian Congo; chemotherapy; and prophylaxis by measures against Simuliids. An account is given of the development of *O. volvulus* in *S. damnosum*, in which the cycle was completed in 6–7 days [*cf.* **36** 148], and of its partial development in *S. albivirgulatum* and *S. faini*, in which the cycle was abortive. Comparative rates of infection in *S. damnosum* and *S. albivirgulatum* in nature were also studied [*cf.* **36** 148]. It is concluded that *S. damnosum* is the only vector near Leopoldville.

Prophylactic measures include personal protection from Simuliids, principally by the use of repellents. In experiments in which these were applied to the leg at 1 cc. per 600 sq. cm., dimethyl phthalate, Indalone, 2-ethyl-1,3-hexanediol, the 6-2-2 mixture of these three and KIK Geigy (14·2 per cent. by weight of the diethylamide of o-chlorobenzoic acid, 11·6 per cent. morpholide of 3,4-dimethylbenzoic acid, 5·8 per cent. N-crotonyl-N-ethyl-o-toluidine and 68·4 per cent. isopropyl alcohol) gave protection for average periods of 2, 7, 6, 5 and 10 hours, respectively, in places where

untreated men were attacked by ten Simuliids per minute. Other measures discussed are prevention of infiltration of the vector to an area by treating the surrounding vegetation with DDT, which, however, was unsuccessful; mechanical clearing of larvae from their supports, destruction of supporting vegetation and periodical diversion of water; the use of larvicides; and the distribution of aerosols from aircraft over breeding areas against the newly emerged adults of both sexes and the gravid females that assemble there. Within two days of the beginning of intensive application of DDT aerosols at 20 mg. p,p′ DDT per sq. metre to both the Belgian and French banks of the Congo and the islands between them in October 1948, Leopoldville-Ouest was practically freed of *S. damnosum*, and the native villages within about 20 miles of the river were clear of it in four days. Breeding in places accessible for examination by land or water was found to have ceased after three weeks. Fluctuation in water level was thought to be a contributing factor to the satisfactory result, but subsequent experience proved that aerosols alone can clear breeding places even when the flow of the water is favourable to reproduction. *S. damnosum* was not subsequently seen in inhabited districts near the rapids, but small numbers were still to be found on the accessible islands and occasional females entered Leopoldville. These were subsequently found to be coming from the French side and reconnaissance confirmed the need for complete treatment of the river Djoué, a tributary entering the Congo at Leopoldville. No cases of onchocercosis are known to have occurred among Europeans in Leopoldville in the two years following the campaign. It is too early to estimate the effect of treatment on the native population.

S. albivirgulatum and *S. faini* were eliminated from Leopoldville by applying large quantities of BHC dust to the sources of the small rivers in which they breed [*cf.* **36** 148] so that the water at the junction of the river with the main stream contained 3 parts γ BHC per million.

Travis (B. V.). **Effectiveness of Repellents against several Species of *Anopheles* Mosquitoes.**—*J. nat. Malar. Soc.* **10** no. 3 pp. 197–205. Savannah, Ga., 1951. (With a Summary in Spanish.)

Results of field and laboratory tests with repellents applied to the skin to give protection against different species of *Anopheles* are summarised. All tests against *A. quadrimaculatus* Say, *A. maculipennis freeborni* Aitken and *A. punctipennis* (Say) were made in the laboratory. The average repellent time (minutes to first bite) was the criterion of effectiveness. Of 4,313 repellents tested against *A. quadrimaculatus* in 1942–45, 142 were effective for 91 minutes or more. Lists are given of these, with the average repellent times of the 30 that were effective for more than two hours. Only p-isopropoxybenzaldehyde, α-amylcinnamaldehyde, methyl β-diethylaminocrotonate and N-amylsuccinimide were effective for three hours. The four standard repellents, dimethyl phthalate, 2-ethyl-1,3-hexanediol, Indalone, and the 6-2-2 mixture of them had average repellent times of 108, 53, 41 and 147 minutes. *A. m. freeborni* and *A. punctipennis*, with which tests were made in 1945, were more easily repelled, 8 of 49 materials, including dimethyl phthalate and ethylhexanediol being effective for more than seven hours against the former and 5 of 12 against the latter. The results for all the materials are given in a table. In laboratory tests with dimethyl phthalate, ethylhexanediol and Indalone made by D. M. Jobbins in Panama against *A. albimanus* Wied., only ethylhexanediol was effective for more than an hour. In field tests in 1942 against a mixed population in which *A. albimanus* predominated, subjects treated with ethylhexanediol, dimethyl phthalate and Indalone received an average of 0·4, 3·2 and 15·8 bites in two

hours and 0·8, 10·2 and 27·9 in three hours [*R.A.E.*, B **35** 51]. *A. gambiae* Giles was repelled for less than an hour by dimethyl phthalate, ethylhexanediol or Indalone in cage tests by L. Berner in Africa. In field tests against populations of *Anopheles* spp. in which *A. gambiae melas* Theo. predominated, five out of six materials protected for more than five hours and for longer than the 6-2-2 mixture, N-amylsuccinimide being possibly the most effective. Indalone, dimethyl phthalate and ethylhexanediol gave good protection for 2½ hours and partial protection after 8 hours against *A. aquasalis* Curry in field tests by the late R. C. Shannon in Trinidad in 1943.

Smith (C. N.) & Cole (M. M.). **Mosquito Repellents for Application to Clothing.**—*J. nat. Malar. Soc.* **10** no. 3 pp. 206–212, 1 ref. Savannah, Ga., 1951. (With a Summary in Spanish.)

In 1948–49, field tests were carried out against salt-marsh mosquitos (*Aëdes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlk.)) and laboratory tests against *A. aegypti* (L.) and *Anopheles quadrimaculatus* Say to find repellents that would remain effective on clothing after several days' wear or several weeks' storage. All treatments, except in the test with aerosols, were made by impregnating cloth with acetone solutions or emulsions. The most effective repellents against the salt-marsh mosquitos were methyl-N,N-diisopropyladipamate and 2-butyl-2-ethyl-1,3-propanediol, which at 3 gm. per sq. ft. gave protection for 56 hours of wear [*cf. R.A.E.*, B **39** 167] and N-butyl-1,2,3,6-tetrahydrophthalimide, Indalone and undecylenic (hendecenoic) acid, which were effective for 48 hours. The outstanding individual repellents against *Aëdes aegypti*, *Anopheles quadrimaculatus* or both were 2,4-nonanediol [*cf. loc. cit.*], N-butyl-1,2,3,6-tetrahydrophthalimide, 2-butyl-2-ethyl-1,3-propanediol and dimethyl phthalate.

Some of the most effective mosquito repellents were tested in mixtures containing outstanding tick, flea and Trombiculid repellents to provide all-purpose treatments for clothing. The most effective mixture against the three types of mosquitos was M-1960, consisting of equal parts of 2-butyl-2-ethyl-1,3-propanediol, N-butylacetanilide, an outstanding repellent against ticks and oriental rat fleas [*Xenopsylla cheopis* (Roths.)], and benzyl benzoate, which is effective against cat fleas [*Ctenocephalides felis* (Bch.)] and Trombiculid larvae [*cf.* **40** 62]. This mixture was also more effective against the various mosquitos than any of the individual repellents.

Where sprayed on stockings as aerosols, Indalone, dimethyl carbate, ethyl β-phenylhydracrylate and 2-butyl-2-ethyl-1,3-propanediol were equal to or slightly better than the same materials in acetone solution.

Hunninen (A. V.). **Comparative Susceptibility of four Anopheline Mosquitoes to** *Plasmodium relictum*.—*J. nat. Malar. Soc.* **10** no. 3 pp. 216–223, 4 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

A study was made of the susceptibility of four species of *Anopheles* to *Plasmodium praecox* (*relictum*). Species of *Culex* were used as controls. The percentages of females of *A. albimanus* Wied., *A. maculipennis freeborni* Aitken, *A. quadrimaculatus* Say and *A. crucians* Wied. that became infected after feeding on infected birds were 80, 54, 35 and 33 as compared with 91·5, 100, 86·5 and 93·5 per cent. of the respective controls. Complete development of the parasite occurred in all four species of *Anopheles*, though the rate of development in them was slower than in a normal host. More oöcysts were found when the sparrows on which the mosquitos fed were infected with a sparrow strain of *P. praecox* than when they were infected

with a strain from starlings. When sporozoites from three species of *Anopheles* and two of *Culex* were injected into sparrows, all produced infections. Similar inoculations failed to produce infections in canaries.

Markos (B. G.). **Distribution and Control of Mosquitoes in Rice Fields in Stanislaus County, California.**—*J. nat. Malar. Soc.* **10** no. 3 pp. 233–247, 9 figs., 10 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

The following is substantially the author's summary. Observations in Stanislaus County, California, during the summer of 1947 showed that rice-fields produce large numbers of mosquitos, which appear in three well-defined peaks. Members of the genus *Aëdes*, represented by *A. dorsalis* (Mg.), *A. nigromaculis* (Ludl.) and *A. vexans* (Mg.), appeared immediately after flooding, and then disappeared. *Culex tarsalis* Coq. appeared in early summer, reached its peak during the last week of June and first week of July and was followed in the late summer by *Anopheles maculipennis freeborni* Aitken, which reached its peak during August and September. Larvae of all the species were well distributed throughout the plots, and the centres of plots, examined by plank bridge, were as productive as were areas adjacent to the levees. In view of this and because of the extensive areas involved, control is virtually confined to spraying from aircraft. DDT and DDD, applied in this way at 0·3 lb. per acre in emulsified solution, gave excellent control of the larvae for 1–2 weeks.

Resnick (S. L.) & Crowell (R. L.). **Comparative Evaluation of certain High Pressure insecticidal Aerosols against** *Musca domestica*.—*J. nat. Malar. Soc.* **10** no. 3 pp. 248–256, 4 figs., 4 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

Experimental formulations for high-pressure liquefied-gas aerosols were compared with G-382, an approved formulation in which the insecticides are 5 per cent. pyrethrum extract (20 per cent. pyrethrins) and 3 per cent. DDT [*R.A.E.*, B **39** 186], for controlling insects of medical importance in aircraft. All contained 85 per cent. Freon 12 [dichlorodifluoromethane] as the propellent, and the tests were made in modified Peet-Grady chambers against insectary-reared house-flies (*Musca domestica* L.). A formula containing only 2 per cent. pyrethrum extract with 1 per cent. piperonyl butoxide, 8 per cent. 264 (N-(2-ethylhexyl)bicyclo [2.2.1]-5-heptene-2,3-dicarboximide) and 3 per cent. DDT was cheaper than the standard G-382 and 1·4 times as effective. However, it irritated the mucous membranes of the nose and throat, and formulations containing piperonyl butoxide at 1 per cent. or more are recommended for use only in the absence of passengers. When the pyrethrum content was reduced to 1 per cent., effectiveness was about the same as that of G-382. The combination of 1 per cent. piperonyl butoxide and 8 per cent. 264 as synergists maintained the effectiveness of the formula containing 2 per cent. pyrethrum extract against house-flies of a DDT-resistant strain whereas G-382 was only 40 per cent. as effective against these flies as against normal ones.

Substitution of allethrin for the pyrethrins in G-382 caused no loss in effectiveness, but the synergistic action of piperonyl butoxide and 264 was not so evident in formulations containing allethrin as in those containing pyrethrum extract. Lethane 384 (50 per cent. β-butoxy-β′-thiocyanodiethyl ether in petroleum distillate) showed considerable promise as an effective ingredient in aerosol formulations provided that they also contained DDT as well as pyrethrum extract.

Trapido (H.). **The Toxicity of DDT to *Anopheles claviger* (Meigen) in Sardinia and on the Italian Mainland.**—*J. nat. Malar. Soc.* **10** no. 3 pp. 266–271, 10 refs. Savannah, Ga., 1951. (With Summaries in Italian and Spanish.)

Differences in the susceptibility of larvae of different species or strains of mosquitos to DDT or a similar larvicide could be assessed by either of two criteria, the median lethal dose (LD50) or the dose required to kill nearly 100 per cent. which the author refers to as the basic minimum lethal dose or MLD. The likelihood that mosquitos or mosquito larvae may develop resistance to chlorinated insecticides applied against them, and also that resistance in adults may be reflected in larvae, makes it desirable to record the initial toxicity of the various chemicals to the larvae of species of medical importance as a basis for future comparisons. The ways in which tests to this end should be standardised are briefly discussed.

The intensive and prolonged use of DDT against adults and larvae of *Anopheles maculipennis labranchiae* Flni. in Sardinia [*cf. R.A.E.*, B **40** 194] has also involved the repeated treatment of the breeding places of *A. claviger* (Mg.). To ascertain whether the latter had acquired any resistance, larvae collected in Sardinia and others from springs, which had never been treated with DDT, at Ninfa on the Italian mainland were exposed early in the fourth instar to DDT at various concentrations in acetone-water suspension. Mortality was estimated after 48 hours. The results are given in a table together with those obtained by various workers in Florida in similar tests with larvae of *A. quadrimaculatus* Say.

The MLD for *A. claviger* was 1 part DDT in 10 million parts water, which killed 98 and 95 per cent. of the Sardinian and Ninfa larvae, respectively, whereas that for larvae of *A. quadrimaculatus* had been about 1 : 200 million. The mortalities obtained at these and several other concentrations indicate that *A. claviger* has an inherent resistance to DDT much greater than that of *A. quadrimaculatus* but had not acquired any increased resistance in Sardinia.

Trapido (H.). **Factors influencing the Search for Anopheline Larvae in Sardinia.**—*J. nat. Malar. Soc.* **10** no. 4 pp. 318–326, 4 figs., 6 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

When the population of *Anopheles maculipennis labranchiae* Flni. in Sardinia had been greatly reduced [*R.A.E.*, B **40** 195], it became necessary to devise efficient means of locating the places in which it was still present in small numbers. It was found that dipping for the larvae was not a reliable means of establishing their presence or absence when populations were very low, and observations on *A. claviger* (Mg.) showed that Anopheline larvae are not invariably at or near the water surface. Records were therefore made in the laboratory of the periods for which larvae of *A. m. labranchiae*, *A. claviger*, *A. hispaniola* (Theo.) and *A. algeriensis* Theo. remain below the surface of the water after mechanical disturbance. Those of *A. m. labranchiae* returned to the surface more rapidly than the others. The percentages of the four species still submerged after one minute were 2, 39, 36 and 45, respectively. In trials with 328 larvae of *A. m. labranchiae*, the maximum duration of submergence was three minutes, whereas among 300 larvae of *A. claviger*, 258 of *A. hispaniola* and 31 of *A. algeriensis*, maximum submergence times were 14, 35 and 4 minutes, respectively. The ability of *A. claviger* to remain submerged for long periods may be related to the fact that it is apparently capable of cuticular respiration, passing the winter in the larval stage, sometimes in

water under ice. In Sardinia, larvae of *A. claviger* and *A. hispaniola* occur along streams in water that probably has a high content of dissolved oxygen. This would help them to maintain themselves under the surface by cuticular respiration. The probable effect of avoidance of the water surface on the adequacy of dipping and the effectiveness of treatment with oil-base larvicides that kill at the surface is briefly discussed.

Sumerford (W. T.), Fay (R. W.), Goette (M. B.) & Allred (A. M.). **Promising DDT-synergist Combinations for the Control of Resistant Flies.**—*J. nat. Malar. Soc.* **10** no. 4 pp. 345–349, 13 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

In rapid preliminary experiments, 2,400 compounds were tested for possible synergistic action with DDT against house-flies (*Musca domestica* L.) resistant to the latter. Combined deposits of 200 mg. DDT and 20 mg. test compound per sq. ft. were used when one week old, and exposure was for two hours. Mortality from the control deposits of 200 mg. DDT alone was negligible. The results indicated that 17 of the compounds were about equal to or better than DMC (1,1-bis(p-chlorphenyl)ethanol), which had been previously shown to have a marked synergistic action, though it was relatively non-toxic to house-flies by itself. However, in more critical laboratory tests on 7 of the 17 compounds and DMC with exposure for 30 minutes to deposits four weeks old of 200 mg. DDT with 20, 40 or 200 mg. test compound, only three continued to show promise. These were p-chlorophenyl 1,2-dichloro-2-(p-chlorophenyl)ethyl ketone, which gave 100, 97 and 100 per cent. kill of males and 95, 86 and 100 per cent. kill of females in 24 hours at the three concentrations, DMC, for which the corresponding percentages were 5, 88 and 89 and 8, 68 and 71, and 1,1-bis(p-chlorophenyl)ethane for which they were 1, 29 and 99 and 2, 2 and 81.

Downs (W. G.) & Bordas (E.). *Anopheles aztecus*. **Malaria, and Malaria Control in the Valley of Mexico.**—*J. nat. Malar. Soc.* **10** no. 4 pp. 350–358, 17 refs. Savannah, Ga., 1951. (With a Summary in Spanish.)

Malaria is endemic in the Xochimilco-Mixquic region of the Valley of Mexico, at an altitude of 7,400 ft., and *Plasmodium vivax* is the only malaria parasite established there. Data are given on house captures of Anophelines and on experiments from which it is concluded that *Anopheles maculipennis aztecus* Hffm., which is almost the only Anopheline found in houses, bites man readily, has been found naturally infected in the region, can be readily infected in the laboratory, and can transmit *P. vivax*, is the only malaria vector of importance in the region. A malaria-control programme consisting of spraying all houses and other buildings in the parts of towns near breeding areas with DDT, applied at 200 mg. per sq. ft. in wettable-powder suspension, gave excellent results. After 15 months, parasite rates had dropped to zero and spleen rates had fallen markedly. A second spraying after an interval of two years and subsequent ones only when autochthonous cases of malaria appear are recommended.

Knight (K. L.) & Abdel Malek (A. A.). **A morphological and biological Study of *Culex pipiens* in the Cairo Area of Egypt (Diptera-Culicidae).** —*Bull. Soc. Fouad Ier Ent.* **35** pp. 175–185, 7 refs. Cairo, 1951.

The name *molestus* Forsk. is now commonly used for the form of *Culex pipiens* L. that combines the characters of autogeny, stenogamy, homodynamy and man-biting [*cf. R.A.E.*, B **40** 63], though it was not known

whether a form possessing this combination of characters occurred in Egypt, the country that includes the type locality of *C. molestus* [*cf.* **33** 94]. The morphological and biological characters of *C. pipiens* in Cairo were therefore studied and an attempt made to record them in such a way that they could be compared with those of *pipiens* populations from other regions [*cf.* **41** 121]. Immature stages were collected from as many different types of suburban breeding places around Cairo as possible, and the freshly emerged adults of each sample (including at least 100 of each sex) were kept in a small cage (ten-inch cube) for at least 12 days to allow all autogenous eggs to be laid. The proportion of females able to oviposit autogenously was estimated by dividing the number of rafts by the number of females put into the cage, and the degree of stenogamy by dissecting the spermathecae of ten females from each cage on the twelfth day. On the same day, 30 of the females were offered a human hand and another 30 the inner plucked surface of a pigeon's wing, and the percentages that fed in 30 minutes were determined. Fed females were kept for about 25 days to allow oviposition. The shape, number of eggs and percentage hatch were determined for all egg rafts, and adults from each sample were kept for morphological study.

Morphological characteristics are given for adults, eggs and rafts and fourth-instar larvae. Eggs in rafts from fed females were more often regularly arranged than those in autogenously produced rafts. Females that had fed on pigeon blood produced larger rafts than those that had fed on human blood, and the rafts of both were larger than those produced by unfed females. There was no appreciable difference in the average hatching rate of eggs from the three sources. Only 0–4 per cent. of females (average 1·1) oviposited autogenously, but the autogeny percentage also averaged 1·1 in the F_1 generation reared from some of the anautogenous batches [*cf.* **41** 119]. Females in all the samples produced fertile eggs when kept in the small cages, and the stenogamy rate was 84 per cent. in August when temperatures were at their highest and 100 per cent. in October and November. Each of the tested samples accepted human and pigeon blood, some taking one more readily and some the other. It was evident that part at least of the Cairo *pipiens* population is homodynamic, as eggs could be found in the area throughout the year. Larvae were found in habitats varying from clean, clear-water ground pools to murky, strongly polluted cesspools. The pH of breeding places ranged from 7·8 to 8·7 and the chloride content from 0·01 to 0·46 per cent. Available data were inadequate to determine whether any correlation exists between larval environment and adult characteristics.

It is concluded that the Cairo population has most of the characters summarised [**40** 63–64] for *molestus*. It did not conform as to four morphological characters, but none of these has been reported in the literature as of diagnostic value by more than one worker. The authors consider that variants should be designated only with non-committal or "vernacular" names and propose that the vernacular name, form "molestus", be applied to the Cairo population. It is not known whether it will prove to be confined to urban areas in Egypt. No material resembling *C. p. fatigans* Wied. has been found by the authors or other contemporary workers in Egypt.

As so few females of the Cairo population are autogenous, it seems likely that the stenogamous, homodynamic and mammal-biting biotype found by Roubaud in Algeria and named by him *C. p. berbericus*, which he at first thought to be anautogenous [**21** 267] but later found to exhibit autogeny on occasion [**27** 213; **35** 119], should also be known as form "molestus" [*cf.* **40** 63].

Eligh (G. S.). **Factors influencing the Performance of the Precipitin Test in the Determination of Blood Meals of Insects.**—*Canad. J. Zool.* **30** no. 4 pp. 213–218, 1 pl., 12 refs. Ottawa, 1952.

The following is the author's summary. Certain factors influence the performance of precipitin tests when the latter are used for detection of blood meals of biting flies. Antisera stored in a liquid state in a refrigerator generally show a decrease in titer with the passage of time. Aging appears to have an adverse effect on the avidity of an antiserum. Smears of blood-engorged mosquitoes prepared by smearing of the entire insect are satisfactory for testing by the precipitin reaction. A high-titered antiserum which can be diluted is desirable for detection of host blood in mosquitoes.

Fisher (R. W.). **The Importance of the Locus of Application on the Effectiveness of DDT for the House Fly, *Musca domestica* L. (Diptera: Muscidae).**—*Canad. J. Zool.* **30** no. 4 pp. 254–266, 1 pl., 2 figs., 15 refs. Ottawa, 1952.

Solid DDT cannot be applied in measured doses to selected regions of insect integument, and dilute solutions in benzene spread over excessively large areas. As concentrated solutions could not be dispensed from a syringe without crystallisation taking place, droplets of a 1 per cent. solution of DDT in benzene produced by a 0·25 ml. syringe combined with a microfine glass tube and a rocking microtome (to regulate the plunger movement), were allowed to evaporate to a highly viscous state on water. The saturated droplets or crystalline masses were applied to different areas of the integument of adult males of *Musca domestica* L., harmlessly immobilised in cellulose tape holders. The methods of rearing and immobilising the flies, and of producing and evaporating the droplets and transferring them with glass applicators are described, and the results of observations on differences in the effectiveness of the DDT when applied to different areas are given and discussed.

It has been assumed that the tarsomeres and particularly the pulvilli are the normal sites of sorption, but in these experiments the pulvilli were relatively ineffective sites for the application of DDT either as a crystalline mass or in supersaturated solution. It is suggested, therefore, that DDT accumulated on the tarsi is distributed to more susceptible areas by the cleaning movements of flies. A correlation has been suggested between susceptibility and the chemoreceptive sensillae found ventrally on the tarsomeres of the leg of *M. domestica* and lacking from those of more resistant insects [*R.A.E.*, B **38** 11], but in this work, the first tarsomere, which bears no sensillae, was a more effective point of application than the third, fourth and fifth tarsomeres, which have large numbers of sensillae. There is no evidence that the thickness of the cuticle in *M. domestica* plays any part in preventing or retarding entry of DDT [*cf.* **39** 84]. Widely different mortalities were caused by application of DDT to different loci, the greatest difference being between the pulvilli and the labella. There appeared to be a tendency for mortality to be lower as the site of application moved distally along the legs and posteriorly from head to abdomen. Pulsatile organs (accessory hearts) beneath sites of application enhanced effectiveness. No difference was noted in the mortality caused when the DDT in solution was applied to sclerotised areas of the legs (femur and tibia) and membranous areas without pulsatile organs (coxotrochanteral membrane and tibiotarsal membrane).

The size of the cuticular area available to the DDT-benzene droplets profoundly affected mortality. Effectiveness of treatment of the labella may

have resulted from the relatively large area presented by the pseudotracheae. These would tend to increase the spreading of the droplet by capillarity over a comparatively large area of the integument. By isolating areas of cuticle on the mesonotum, it was found that mortality decreased progressively as the available area was decreased. This may be attributed to the number of sensory endings affected, the amount of the cuticular nerve net exposed, the number of hypodermal cells affected, or the limit placed on the amount of DDT that can penetrate the cuticle in a given time. It has been shown [**38** 209] that DDT is changed to non-toxic metabolites in resistant flies and that a small proportion of it is changed to some other material in susceptible ones. The latter material may be the actual toxin, and the cuticle hypoderm cells may be involved in the change. If so it is conceivable that benzene or DDT might incapacitate cells immediately beneath the point of application, where the concentration is highest, so that only those cells lying beyond this region would prove effective in the toxic mechanism. To account for instances reported in the literature in which direct application to isolated nerves produced symptoms, it would be necessary to postulate a separate mechanism or suspect integumental contamination. A large dose of crystalline DDT inserted into the tissues of the mesothorax had no toxic effect. This emphasises again the importance of the cuticle.

West (A. S.) & Eligh (G. S.). **The Rate of Digestion of Blood in Mosquitoes. Precipitin Test Studies.**—*Canad. J. Zool.* **30** no. 5 pp. 267–272, 13 refs. Ottawa, 1952.

Almost all of the following is from the authors' summary. The use of the serological procedure known as the precipitin test to study the rate of digestion of host blood in mosquitos is described. In the laboratory, at constant temperatures, precipitin reactions were obtained on blood-meals of *Aëdes aegypti* (L.) eight days after engorgement when the mosquitos were kept at 11°C. [51·8°F.] but only one or two days after engorgement when they were kept at 27°C. [80·6°F.]. Field studies with *A. hexodontus* Dyar in northern Manitoba also showed that temperature has a strong influence on the rate of digestion. Pertinent literature is reviewed, and the limitations of the precipitin test are discussed. It will not indicate when the digestion of the blood has been completed, since the presence of blood fractions was demonstrated ten and 11 days after the blood-meal in examples of a series of *A. hexodontus* from which precipitin reactions were not obtained after the eighth day. Little attention has hitherto been devoted in Canada to possible transmission of disease by mosquitos. The importance of increasing knowledge of mosquito physiology is indicated by world-wide interest in mosquitos as vectors of encephalitis viruses and the recovery of a strain of western equine encephalitis from *Culex restuans* Theo. in Manitoba.

Davies (D. M.). **The Population and Activity of adult female Black Flies in the Vicinity of a Stream in Algonquin Park, Ontario.**—*Canad. J. Zool.* **30** no. 5 pp. 287–321, 27 figs., 19 refs. Ottawa, 1952.

The following is the author's summary. The population of females of *Simulium venustum* Say on the wing was measured by hand-netting. The population varied annually and seasonally coincident with the number and longevity of immigrant and emergent flies. Longevity in turn was probably related to the rainfall.

Activity was divided into flying, attraction, landing, and biting, the first two measured by hand-netting and the last two by counts on a unit area of human skin in the shade. Flying usually varied diurnally, a large peak in the evening and a small one in the morning. Attraction varied with none of the meteorological factors measured. Biting and flying increased and landing decreased with rapidly changing, especially falling, pressure. Other factors influenced flying and landing, but not biting, when the area was in the shade. Flying was greatest between 60–80°F., at low but not zero saturation deficiencies, in light winds, and in zero to low rates of evaporation. Landing on the host was least below 55°F. and at 65–75°F., at zero and intermediate saturation deficiencies, and at moderately high rates of evaporation. These factors affected the flies landing on the host directly, and indirectly by curtailing the flying that brought flies to the host in the first place. In the direct sunlight landing decreased to one-half and biting to one-quarter of that in the shade.

Abdussalam (M.) & Sarwar (M. M.). **Trees as Habitats of the Fowl Tick, *Argas persicus* (Oken).**—*Bull. ent. Res.* **44** pt. 3 pp. 419–420, 3 refs. London, 1953.

The following is virtually the authors' summary. All stages of *Argas persicus* (Oken) were found in crevices in the bark of 49 of 266 trees belonging to 16 species in West Pakistan. These trees had not been used as roosts by domestic birds. The infestation seemed to be restricted to trees used by vultures (*Pseudogyps bengalensis*) or herons (*Ardea cinerea*) for nesting or roosting. Several of the ticks collected contained recently sucked avian blood in the gut, but intramuscular injection of a saline suspension of crushed material from the ticks into a hen produced no blood infection. Infested trees may be important as sources of the pest near poultry farms and hen houses.

Weitz (B.) & Buxton (P. A.). **The Rate of Digestion of Blood Meals of various haematophagous Arthropods as determined by the Precipitin Test.**—*Bull. ent. Res.* **44** pt. 3 pp. 445–450, 5 refs. London, 1953.

The rate of digestion in ten species of blood-sucking arthropods was studied by means of precipitin tests [*cf. R.A.E.*, B **41** 209]. Eight of the species (*Aëdes aegypti* (L.), *Anopheles maculipennis atroparvus* van Thiel, *Culex pipiens molestus* Forsk., *Culicoides nubeculosus* (Mg.), *Cimex lectularius* L., *Bdellonyssus bacoti* (Hirst), *Ornithodoros moubata* (Murr.) and *Glossina morsitans* Westw.) were fed in the laboratory. Females of *A. aquasalis* Curry were killed at known intervals after entering a trap baited with an ox on which they fed, and adults of *G. swynnertoni* Aust. were taken in the field, the times that had elapsed since their feeding were estimated from their external appearance (hunger stage), and only those that had fed on mammalian blood were used for the tests.

The following is almost entirely based on the authors' summary of the results. The tests gave 80–100 per cent. positive reactions after 16–24 hours with *Culicoides* and the mosquitos, whether naturally or artificially fed. In the case of *Glossina*, the rate of digestion was slower in the captive flies (*morsitans*); 75–100 per cent. of them gave reactions after three days, whereas only 28 per cent. of the wild flies (*swynnertoni*) did so after a similar interval. Positive results were obtained for more than six months with *O. moubata* and for only about one day with *B. bacoti*. *Cimex lectularius* gave 97 per cent. reactions after ten days.

Senior White (R. A.). **On the Evening Biting Activity of three Neotropical *Anopheles* in Trinidad, British West Indies.**—*Bull. ent. Res.* **44** pt. 3 pp. 451–460, 3 refs. London, 1953.

The evening biting activity at ground level in the three commonest species of *Anopheles* in Trinidad (*aquasalis* Curry, *albitarsis* Lynch Arrib. and *neomaculipalpus* Curry) was studied by a method modified from that of Lumsden [*R.A.E.*, B **40** 78–79] to yield data on ovarian and fertilisation states over a period of ten months including the dates of the latest and earliest sunset (6.25 and 5.35 p.m.) at 10°N. lat. Catches were made on 27 evenings. They began 20 minutes before sunset, generally lasted two hours and were divided into ten-minute periods. Females about to attack man were caught before the proboscis was inserted and were given sugar-soaked cotton to maintain them overnight. Females of *A. aquasalis* comprised 94·4 per cent. of a total catch of 8,592. Just over 18 per cent. were newly emerged, and only about half of these were fertilised. Relict eggs, denoting a second or later gonotrophic cycle, were found in February, June and July. In earlier work, they had been found between December and February and between July and September. Nearly 80 per cent. of the evening attack, which is a large proportion of the total night's attack, took place between 20 and 60 minutes after sunset. From one hour after sunset, the proportion of freshly-emerged females was well below the mean, so that the second hour after sunset provides the greatest risk of infection with malaria when age and not numbers attacking, is considered. Activity was greater on moonlit than on moonless evenings. *A. albitarsis* had one major period of biting activity lasting 20 minutes and beginning 20 minutes after sunset. There was a well-marked decrease over the next 20 minutes, followed by a secondary rise. Less than 4 per cent. of the females were newly emerged, and the fertilisation index of these was the same as in *A. aquasalis*. It is suggested that the feeding habits of newly emerged females may differ from those of older ones. Nothing is known of pairing habits. Almost one-third of the small number of females of *A. neomaculipalpus* taken were newly emerged, but all were already fertilised.

Hocking (K. S.) & Yeo (D.). **Aircraft Applications of Insecticides in East Africa. I. Preliminary Experiments in Areas supporting Populations of the Tsetse Fly** (*Glossina palpalis* **(R.-D.)**).—*Bull. ent. Res.* **44** pt. 3 pp. 589–600, 3 figs., 6 refs. London, 1953.

Hocking (K. S.), Parr (H. C. M.), Yeo (D.) & Robins (P. A.). **II. An experimental Attempt to produce a Fly-free Corridor through a Belt of Tsetse-infested Woodland.**—*T.c.* pp. 601–609, 4 figs., 4 refs.

Details are given in the first part of preliminary experimental applications of coarse insecticidal sprays and coarse aerosols from aircraft over densely forested islands in Lake Victoria (Uganda) against *Glossina palpalis* (R.-D.). Oil solutions of technical DDT or crude BHC were used for the aerosols, which were intended to kill by contact and emulsified solutions of the same insecticides for the sprays, which were intended to leave lethal deposits on vegetation.

The following is virtually the authors' summary of the results. Both sprays and aerosols were relatively ineffective at 0·2 lb. p,p'DDT or 0·032 lb. γ BHC per acre, and significant kills were obtained only with the aerosols. The sprays were ineffective not only because they did not penetrate the canopy, but also because the nominal dosage was in any case too small to produce lethal deposits on vegetation. Much of the aerosol was filtered out by the upper layers of the canopy. The meteorological conditions in the

area were also unsuitable for the application of aerosols, and much of the insecticide was blown away from the treated area. It is concluded that the application of insecticides from aircraft in dosages adequate to give substantial reductions of populations of *G. palpalis* would be too costly to be practicable. If insecticides are to be of value in the densely wooded habitats of this species, ground methods of application would be almost certainly more effective and less costly.

In the second part, an experimental attempt to produce a fly-free corridor for moving cattle through a belt of savannah woodland harbouring *Glossina swynnertoni* Aust. is described. An area two miles wide and four miles long in northern Tanganyika was treated with a coarse spray of a 4·6 per cent. w/v solution of technical DDT (80 per cent. p,p′isomer) in oil. The dosage per application was 0·5 gals. per acre, and seven applications were made at intervals of about two weeks, so that the treatment covered two pupal periods. Fly density had fallen to a very low level by the end of the experiment, and the area remained virtually free from flies for the next two months, after which their numbers rose again. An examination of the data suggests, however, that the fly population was maintained largely by immigrant flies and was subject to wide variations. It seemed certain that the average kill of flies per application was not much greater than 70 per cent., so that treatment continued for two pupal periods would be expected to give only about 90 per cent. reduction of a stable, self-supporting population. More prolonged treatment would not be economical, particularly as later work has shown that kills of the order of 95 per cent. per application are obtained when a coarse aerosol, with droplets varying in diameter from 5 to 250 μ, is used in savannah woodland at the same nominal dosage.

The drop spectrum of the ground deposit from the spray had a mass median diameter of 0·35 mm., and the recovery of insecticide in the area was about 60 per cent. Leeward sides and undersides of obstacles did not normally receive deposits. The occasional occurrence of deposits on apparently leeward sides is attributed to a probable local reversal of wind direction.

Papers noticed by Title only.

Leeson (H. S.). **Some Notes on the recorded Distribution of Old World Species of *Ornithodoros* (Acarina).**—*Bull. ent. Res.* **44** pt. 3 pp. 517–526, 4 maps, 73 refs. London, 1953.

Gunther (C. E. M.). **A Check List of the Trombiculid Larvae of Asia and Australasia.**—*Proc. Linn. Soc. N. S. W.* **77** pt. 1–2 pp. 1–60, 5 pp. refs. Sydney, 1952.

Fuller (H. S.). **The Mite Larvae of the Family Trombiculidae in the Oudemans Collection: Taxonomy and medical Importance.**—*Zool. Verh.* no. 18, [2+] 261 pp., 10 figs., 51 refs. Leiden, 1952.

Lambrecht (F. L.) & Leleup (N.). **Note concernant la variabilité d'*Anopheles* (*Pyretophorus*) *christyi* Newstead et Carter.**—*Rev. Zool. Bot. afr.* **44** fasc. 4 pp. 328–332, 7 figs., 2 refs. Tervuren, 1951.

LaForge (F. B.) & Green (N.). **Constituents of Pyrethrum Flowers. XXV. The Synthesis of *d*-Cinerolone, Cinerin I, and its optical Isomers.**—*J. org. Chem.* **17** no. 12 pp. 1635–1640, 14 refs. Baltimore, Md., 1952.

Mertin (J. V.). **Pesticides Quarterly Supplement no. 6, May 1953.**—pp. 303–346, 90 refs., multigraph. [Canberra] Dep. Hlth. Aust., 1953. **No. 7, August 1953.**—pp. 347–400, 74 refs. **No. 8, November 1953.**—pp. 401–424, 54 refs. **Index to Supplements nos. 5–8, Feb.–Nov. 1953.**—*T.c.* pp. 425–431. [*Cf. R.A.E.*, B **41** 77, 112.]

Peterson (A.). **A Manual of entomological Techniques.**—7th edn., 11¼ × 8½ ins., v + 367 pp., 182 pls., refs., multigraph. Ann Arbor, Mich., Edwards Bros. Inc., 1953. Price $7.50. [See *R.A.E.*, A **41** 438.]

Fisher (R. A.) & Yates (F.). **Statistical Tables for biological, agricultural and medical Research.**—4th edn. revd., 11¼ × 8½ ins., xi + 126 pp., 66 refs. Edinburgh, Oliver & Boyd, 1953. Price £1 1*s*.

INDEX OF AUTHORS

A reference in heavy type indicates that a paper by the author has been noticed.

Abdel Malek, A. A., **206.**
Abdussalam, M., **210.**
Abonnenc, E., **63, 112.**
Adams, P. G., **34.**
Addison, C. C., **129.**
Adler, S., 17.
Allen, N. N., **104.**
Allred, A. M., **206.**
Anderson, R. I., **65.**
Anduze, P. J., **32.**
Arakawa, K. Y., **131.**
Armitage, P., **7.**
Armstrong, G., **64.**
Ascoli, W. F., **85.**
Audy, J. R., **6, 193.**
Ayroza Galvão, A. L., 92.

Bahmanyar, M., **181, 193.**
Bailey, S. F., **47, 102.**
Baker, E. W., **22.**
Balfour, M. C., **58.**
Baltazard, M., 9, **181, 193.**
Barbesgaard, P., 124.
Barkov, I. P., **185.**
Barlow, F., **154.**
Barnes, S., 156.
Barr, A. R., **15, 145.**
Barretto, M. Pereira, 63, 64.
Bartlett, B. R., **158.**
Bartley, C. E., **178.**
Beckman, H. F., **48.**
Bell, D. S., **50.**
Bentley, O. G., **50.**
Berndt, W. L., **101, 109.**
Berner, L., 203.
Bertram, D. M., **10, 12.**
Bertram, D. S., **7.**
Bigham, J. T., **40.**
Black, R. H., **9.**
Blackith, R. E., **164.**
Blauw, A. S., **65.**
Blynn, E., **33.**
Bodenstein, O. F., **45.**
Bohart, R. M., **102, 168.**
Bonnet, D. D., **77.**
Bonne-Wepster, J., **191.**
Bordas, E., **88, 128, 131, 206.**
Bowen, C. V., **48.**
Bradbury, F. R., **64.**
Bradley, G. H., **30, 88.**
Brannon, C. C., **145.**
Brennan, J. M., **80.**
Briscoe, M. S., **52.**
Britton, H. G., **64.**
Brown, A. W. A., **37, 41.**
Brown, J. H., **45.**
Browning, E., **8.**
Buck, J. B., **49.**
Buckley, J. J. C., 99.
Burgdorfer, W., **95.**
Burgess, R. W., **87, 89, 90.**
Burroughs, A. L., **149.**
Busvine, J. R., **122, 156,** 157, **158.**
Buxton, A. P., **93.**
Buxton, P. A., **210.**

Campbell, R. W. H., 115.
Capdevielle, A., **32.**
Capriles, J. Maldonado, **91.**
Carpenter, S. J., **25, 78.**
Cass, J. S., **186.**
Castillo, C. H., **34.**
Castillo, R. Levi-, **170.**
Celis S., H., **80.**
Chamberlain, R. W., **61.**
Chang (Nai-ch'u), 128.
Chang, T. L., **113.**
Chao (Pao-hsün), **127.**
Cheng, 127.
Chereshnev, N. A., **183.**
Chow, C. Y., **49, 58, 113.**
Christophers, Sir S. R., 116.
Chung (Huei-lan), **127.**
Claborn, H. V., **16, 48, 195.**
Cochran, D. G., **104.**
Cockings, K. L., 6.
Coda, D., **92.**
Cole, M. M., **72, 203.**
Collins, W. E., **138.**
Colorado, M. Correa, **131.**

Cooley, R. A., 134.
Cornelius, J. A., **168.**
Correa, R. R., **92.**
Correa Colorado, M., **131.**
Couch, M. D., **137.**
Covell, Sir G., **116.**
Crewe, W., **27.**
Crowell, R. L., **150, 204.**
Culwick, A. T., **26.**
Culwick, R. E., **26.**
Curnen, E. C., **113.**
Curran, R. F., **136.**

Dahm, P. A., **177.**
Dalmat, H. T., **15.**
Daly, P. F., **147.**
Dampf, A., 63, 64, 86.
Darsie jr., R. F., **148.**
Davey, J. T., **28, 160.**
Davidson, G., **152.**
Davies, D. M., **209.**
Davis, D. E., **31.**
Davis, G. E., **133, 134.**
DeCoursey, J. D., **105.**
DeFoliart, G. R., **139.**
Del Ponte, E., 92.
De Meillon, B., 190.
Denisova, Z. M., **20.**
de Ong, E. R., **77.**
de Pietri-Tonelli, P., **81.**
de Toledo, A. A., **35, 96, 182, 197.**
Dewey, J. E., **174.**
de Zulueta, J., **60.**
Dick, G. W. A., **24, 146.**
Dicke, R. J., **43, 104.**
Diercks, F. H., **31.**
Dorman, S. C., **141.**
Doss, M. A., **32.**
Doucet, J., **190.**
Dove, W. E., 61.
Dow, R. P., **40.**
Downs, W. G., **80, 88, 128, 131, 206.**
Dresden, D., **37, 157.**
Duren, A., 17.
Duret, J. P., **92.**

Eads, R. B., **51.**
Eddy, G. W., **106.**
Edgington, B. H., **50.**
Edney, E. B., **155.**
Edwards, F. I., **48.**
Edwards, F. W., 111, 116,
Eichler, W., **12.**
Eligh, G. S., **208, 209.**
Erwin, W. R., **48.**
Evans, A. M., 190.
Eyles, D. E., **56, 131, 169.**

Fain, A., **29.**
Fairbairn, H., **26.**
Fairchild, G. B., 63.
Fales, J. H., **45.**
Farrar, M. D., **145.**
Fay, R. W., **150, 187, 206.**
Fedyushin, A. V., **66.**
Feinstein, L., **64.**
Feldman-Muhsam, B., **22.**
Feng, L. P., **113.**
Ferguson, F. F., **80, 186.**
Fiedler, O. G. H., **68.**
Fischer, R. G., **86.**
Fisher, Sir R. A., **213.**
Fisher, R. W., **208.**
Fisk, F. W., **135.**
Floch, H., **63, 112.**
Foote, R. H., **148.**
Fox, I., **76.**
Freeborn, S. B., **168.**
Freeman, P., 63.
Frick, L. P., **5, 31.**
Frings, H., **109, 142, 145.**
Frings, M., **145.**
Frizzi, G., **30.**
Fuller, H. S., **50, 212.**
Furman, D. P., **102.**
Furmidge, C. G. L., **129.**

Gahan, J. B., **80.**
Gaines, T. B., **32.**
Galindo, P., **25, 78.**
Gall, D., **155.**
Galvão, A. L. Ayroza, 92.
Gasser, R., **198.**
Gersdorff, W. A., **74, 101, 107, 124, 125,** 166.
Gibbins, E. G., 63.
Gibson, C. L., **85.**
Gilbert, I. H., **137.**
Gillett, J. D., **24, 25, 161.**
Gjullin, C. M., **47,** 167.
Goette, M. B., **206.**
Goodwin, W. J., **175.**
Goulding, R. L., **136.**
Grainger, W. E., **8.**
Gray, H. E., **107.**

Grayson, J. M., **104, 139.**
Green, N., **47, 124, 166, 212.**
Greenberg, H., **71.**
Grenier, P., **49,** 63, 112.
Griffiths, R. B., **194.**
Grunin, K. Ya., **82.**
Gubar', V. V., **19.**
Guelmino, D. J., **163.**
Gunther, C. E. M., **212.**
Gutzevich, A. V., **18.**

Habenicht, G., **68.**
Habibi, A., **181.**
Hackett, L. W., **89.**
Hadaway, A. B., **154.**
Haddow, A. J., **10, 24, 146.**
Hadjinicolaou, J., **135.**
Hall, A. V., **16.**
Hall, W. E., **141.**
Halverson, W. L., **127.**
Hansens, E. J., **135, 171, 178.**
Harris, L., **73.**
Harrison, J. L., **6, 193.**
Harrison, M., 123.
Hassall, A., **32.**
Haufe, W. O., 23.
Hawkins, W. B., **41, 72, 152.**
Hawley, J. E., **187.**
Hayes jr., W. J., **186.**
Heal, R. E., **179.**
Hein, R. E., **177.**
Heisch, R. B., **8, 97.**
Henderson, J. M., **91.**
Henrard, C., **98.**
Hertig, M., 63.
Hess, A. D., **30, 54.**
Hewitt, L. E., **24.**
Hill, R. E., **73.**
Hilsenhoff, W. L., **43.**
Hitchcock, L. F., 195.
Hixson, E., **73.**
Hocking, K. S., **211.**
Hoffman, R. A., **108.**
Holdenried, R., **64, 85.**
Holemans, K., **111.**
Holstein, M. H., **114, 181.**
Hoogstraal, H., **190.**
Hopla, C. E., **200.**
Hornstein, I., **48, 143.**
Horsfall, W. R., **49.**
Hoskins, W. M., **48, 176.**
Houpeau, J. L., **149.**
Howe, R. W., **168.**
Howell, D. E., 18.
Hsu, S. C., **113.**
Hu, S. M. K., **77.**
Huang, 127.
Hughes, M. H., **28, 147.**
Hughes, T. E., **12.**
Humphrey, J. M., **32.**
Hunninen, A. V., **89, 203.**
Hurlbut, H. S., **31, 58, 186.**

Ide, F. P., 24.
Incho, H. H., **71.**
Irons, J. V., **51.**

Jackson, C. H. N., **39.**
Jackson, R. B., **94.**
Jacobson, M., **125.**
Jarvis, M. W., **168.**
Jeffery, G. M., **56, 131.**
Jenkins, D. W., **65.**
Jensen, J. A., **42, 187.**
Jobbins, D. M., 202.
Johnson, C. W., **51.**
Johnson jr., T. H., **53.**

Kartman, L., **15, 144.**
Kaschula, V. R., 194, 195.
Kaul, S., **50.**
Kazakov, B. N., **110.**
Keegan, H. L., **65.**
Keiding, J., **123.**
Keister, M. L., **49.**
Kemper, H., **68.**
Kerr, R. W., **165.**
Khatin, M. G., **111.**
King, H. L., **138.**
Kirk, R., **17.**
Kitchen, W. H., **155.**
Knight, K. L., **121, 190, 206.**
Knipe, F. W., **109, 142.**
Knipling, E. F., **30.**
Knowles, F. A., **130.**
Knutson, H., **77, 140.**
Kocher, C., **69.**
Kochergin, I., **110.**
Kohls, G. M., **17.**
Korshunova, O. S., **18.**
Krieg, H., **146.**
Krishnan, K. V., **4,** 7.
Krusé, C. W., **41, 54, 72, 151.**
Kühl, R., **23.**
Kulp, W. L., **187.**
Kumm, H. W., **59.**

Labrecque, G. C., **136.**
Laemmert jr., H. W., **59.**
LaForge, F. B., **47, 124, 166, 212.**
Laird, M., **200.**
Lambrecht, F. L., **212.**
Lane, J., **32,** 86, **191.**
Laven, H., 119, **120.**
Lavoipierre, M., **194.**
Lebied, B., **13, 29, 62.**
Lee, P., **118.**
Leeson, H. S., **212.**
Legg, J., **180.**
Leleup, N., **17, 30, 112, 212.**
Levi-Castillo, R., **170.**
Levitan, M., **104.**
Lewallen, L. L., **74.**
Lewis, D. J., **17, 38, 118.**
Lewis, G., **118.**
Lhoste, J., **149.**
Lima, F. O., **92.**
Lindquist, A. W., **140.**
Lindsay, D. R., **126.**
Lips, M., **30, 112.**
Lloyd, G. W., **72.**
Lockard, D. H., **135.**
Lofgren, J. A., **101.**
Lombardini, G., **81.**
Longanecker, D. S., **133, 149.**
Longshore jr., W. A., **127.**
Lord, K. A., **168.**
Lototzkiĭ, B. V., **20.**
Love, G. J., **144.**
Ludvik, G. F., **41, 54, 72, 151, 152, 178.**
Lumsden, W. H. R., **93, 146,** 211.
Lyman, F. E., **88.**

McArthur, J., **57.**
McDuffie, W. C., **137.**
McFarland, R. H., **177.**
Macfie, J. W. S., 86.
McGregor, W. S., **45.**
McIvor, B. C., 134.
Mackerras, I. M., 195.
MacLeod, J., 68.
MacMahon, J. P., 50, 63.
Mahalanobis, P. C., 165.
Mail, G. A., **172.**
Makukhin, S. A., **110.**
Maldonado Capriles, J., **91.**
Malek, A. A. Abdel, **206.**
Mann, F. G., **96.**
Manwell, R. D., 191.
March, R. B., **74, 173.**
Markos, B. G., **204.**
Marks, E. N., **161.**
Marshall, J. F., 119.
Martínez Palacios, A., **168.**
Martini, E., **113.**
Mathis, W., **54, 80.**
Matsui, M., **47.**
Mattingly, P. F., **119, 146.**
Meillon, B. De, 190.
Melnick, J. L., **113.**
Mertin, J. V., **77, 112, 213.**
Metcalf, R. L., **74, 173.**
Micks, D. W., **90.**
Miles, V. I., **171.**
Missiroli, A., **60.**
Mitchener, A. V., **143.**
Mitlin, N., **74, 101, 107, 125,** 166.
Mofidi, C., **181, 193.**
Mohr, C. O., **132.**
Moignoux, J. B., **100.**
Moore, G. D., **43.**
Moore III, S., **42, 108.**
Morril jr., A. W., **172.**
Morris, A. P., **49.**
Muhsam, B. Feldman-, **22.**
Muirhead Thomson, R. C., 152.
Mulrennan, J. A., **30.**
Muma, M. H., **73.**

Nair, C. P., **58.**
Nash, K. B., **179.**
Nash, R., **156,** 157.
Nasiruddin, M., **128.**
Nelson, R. H., **101, 107.**
Nel'zina, E. N., **183, 185.**
Newman, J. F., **121.**
Nickerson, W. J., **195.**
Norris, K. R., **195.**
Norris, M. A., **51.**
Nukiyama, S., 55.

O'Colla, P., **112.**
Ong, E. R. de, **77.**
Oppenoorth, F. J., **37, 157.**
O'Rourke, F. J., **27, 28, 160.**

Pal, Rajindar, **94, 124.**
Palacios, A. Martínez, **168.**
Parr, H. C. M., **211.**
Patel, T. B., **191.**
Paules, L. H., **139.**
Pavlovskiĭ, E. N., **185.**

Peel, E., **98, 99.**
Peffly, R. L., **53.**
Penner, L. R., **187.**
Pereira Barretto, M., 63, 64.
Pervomaĭskiĭ, G. S., **67.**
Peters, R. F., **47, 127.**
Peterson, A., **213.**
Peterson, D. G., **52.**
Petrishcheva, P. A., **19.**
Peus, F., 113.
Pfadt, R. E., **139.**
Philen, E. A., **151.**
Philip, C. B., **5, 17.**
Pietri-Tonelli, P. de, **81.**
Pimentel, D., **174.**
Pinotti, M., **56.**
Piontkovskaya, S. P., **18, 51.**
Piquett, P. G., **45.**
Pittendrigh, C. S., **15.**
Ponte, E. Del, 92.
Portman, R. F., **43.**
Posner, I., **49.**
Potts, S. F., **141.**
Pounden, W. D., **50.**
Pringle, G., **40.**

Quarterman, K. D., **54, 80.**
Qutubuddin, M., **36.**

Radeleff, R. D., **195.**
Rajindar Pal, **94, 124.**
Reeves, W. C., **189.**
Rehn, J. W. H., **91.**
Reichmuth, W., 113.
Reid, J. A., **116.**
Repass, R. P., **106.**
Resnick, S. L., **204.**
Richards, R., **45.**
Rickard, E. R., **132.**
Rivers, T. M., **113.**
Roberts, F. H. S., **112, 180.**
Roberts, I. H., **101.**
Robins, P. A., **211.**
Robinson, G. G., **167.**
Rodda (Rodde), S. T., **191.**
Roeder, K. D., **148.**
Rogers, E. E., **138.**
Romanova, V. P., **183.**
Rosický, B., **148.**
Ross, R. W., **24, 25.**
Roth, A. R., **108, 140.**
Roubaud, E., 163, 207.
Roulston, W. J., **195.**
Rousselot, R., **169.**
Rudnick, A., **189.**
Russell, P. F., **30, 116,** 191.
Ryckman, R. E., **84, 131.**

Sabrosky, C. W., **40, 87.**
Salmeron, R., **34.**
Sarkies, J. W. R., **28.**
Sarwar, M. M., **210.**
Sasse, B. E., **89.**
Sauer, H. F. G., **35.**
Sautet, J., 193.
Scharff, J. W., 191.
Schechter, M. S., **47, 124, 166.**
Schomberg, O. C., **45, 46.**
Schoof, H. F., **42, 44, 172.**
Schulze, F., **109.**
Schwardt, H. H., **174, 175.**
Scott, J. A., **33, 51.**
Scott, M. T., **196.**
Selhime, A., **72.**
Senior White, R. A., **118, 211.**
Serrano, J. M., **91.**
Severin, H. C., **107.**
Seydian, B., **181.**
Shannon, R. C., 203.
Sharma, M. I. D., **124.**
Sharp, N. A. D., 99.
Shawarby, A. A., 156, **157.**
Shoshina, M., **184.**
Shute, P. G., **119.**
Simpson, T. W., **188.**
Sinton, J. A., 40.
Sippell, W. L., **37.**
Siverly, R. E., **42, 142.**
Skruinnik, A. N., **83, 185.**
Skuf'in, K. V., **18, 67.**
Smadel, J. E., **5.**
Smith, A. L., **34.**
Smith, C. L., **45, 46.**
Smith, C. N., **72, 87, 203.**
Smithburn, K. C., **146.**
Smith-White, S., 120.
Snow, W. E., **56, 152.**
Snowball, G. J., **195.**
Sosnina, E. F., **20.**
Spear, P. J., **75, 109.**
Spencer, R. A., **141.**
Stabler, R. M., **60.**
Stage, H. H., **30.**
Steiniger, F., **149.**
Steward, J. S., 100.
Stewart, W. H., **126.**
Sukhova, M. N., **82.**

Sullivan, W. N., **143.**
Sumerford, W. T., **206.**
Sundararaman, S., 15, **53.**
Swain, R. B., **109.**
Sweetman, H. L., **42, 75, 109.**
Swellengrebel, N. H., **116, 191.**
Syverton, J. T., **86.**

Tahori, A. S., **176.**
Tanasawa, Y., 55.
Terriere, L. C., **140.**
Terry, E. D., **130.**
Theodor, O., 17, 40.
Thomas, J. I., **58.**
Thomson, R. C. Muirhead, 152.
Tischler, W., **92.**
Toledo, A. A. de, **35, 96, 182, 197.**
Tonelli, P. de Pietri-, **81.**
Trägårdh, I., 22.
Trapido, H., **25, 78, 205.**
Traub, R., **5, 31.**
Traver, J. R., **33.**
Travis, B. V., **34, 202.**
Twinn, C. R., **23.**

Umana, A. C., 92.
Upholt, W. M., **80.**

Vargas, L., **168.**
Vincke, I. H., **17.**
Vinogradskaya, O. N., **84.**

Walker, O. L., **51.**
Wall jr., W. J., **47.**
Walton, G. A., **130.**
Wanson, M., **13, 29, 62, 99, 111, 201.**
Ward, J., **168.**
Warren, J., **113.**
Waterhouse, D. F., **196.**
Watt, J., **126.**
Webster, A. P., **105.**
Wedberg, S. E., **187.**
Weiser, J., **148.**
Weitz, B., **210.**
Wells, R. W., **16, 195.**
Wepster, J. Bonne-, **191.**
West, A. S., 23, **209.**
West, L. S., 191.
Weyer, F., **101, 148, 192.**
Wharton, G. W., **22, 50.**
Wharton, R. H., **162.**
White, R. A. Senior, **118, 211.**
White, S. Smith-, 120.
Wiesmann, R., **69,** 179.
Wilcomb jr., M. J., **171.**
Williams, A. H., **43.**
Williams, M., **179.**
Wilson, S. G., **20.**
Winteringham, F. P. W., **32.**
Wirth, W. W., **85.**
Witkowski, M., 193.
Witt, J. M., **48.**
Wolfinsohn, M., **199.**
Worth, C. B., **66.**

Yates, F., **213.**
Yeo, D., **211.**
Yeomans, A. H., **138.**
Young, M. D., **53, 89, 90, 131.**

Zahar, A. R., **14.**
Zeid, M. M. I., **177.**
Zhivković, V., **112.**
Zhmaeva, Z. M., **83.**
Zhovtuiĭ, I. F., **199.**
Zulueta, J. de, **60.**
Zumpt, F., **13.**

GENERAL INDEX

In the case of scientific names of arthropods, the page references are cited only under the generic headings. Chemical compounds having numerical prefixes (bis-, di-, etc.) are indexed under these prefixes, but the prefixes o-, m- and p- (ortho, meta and para), N- and O- to indicate position of radicals, and normal, secondary and tertiary are ignored for alphabetisation.

A

Acanthocheilonema perstans, in Belgian Congo, **98, 99** ; in Sudan, **38** ; evidence against transmission of, by *Culicoides*, **99** ; occurrence and lack of development of, in *Simulium damnosum*, **38, 99** ; investigations on other possible vectors of, **99.**

Acetone (as solvent), affecting apparent toxicity of DDT to flies, **122, 176** ; in sprays containing n-octyl sulphoxide of isosafrole, **101** ; used to form suspensions of organic compounds in water, **48.**

aconitus, *Anopheles.*

Adhesive Tape, as barrier against *Triatoma*, **85.**

Aëdes, bionomics and control of Canadian species of, **23, 41** ; dry-season survival of adults of, in N. Rhodesia, **167, 168** ; tests of repellents against, **72, 203** ; (*Stegomyia*), of Ethiopian Region, **146.**

Aëdes aegypti, eradication of, from coastal Ecuador, **170** ; incomplete eradication of, in Guam, **103, 189** ; in N. Rhodesia, **167, 168** ; in Uganda, **94** ; distribution of forms of, in Ethiopian Region, **146** ; experiments with *Acanthocheilonema perstans* and, **99** ; and dengue, **103** ; experiments with *Plasmodium gallinaceum* and, **169, 170** ; and yellow fever, **167** ; not responsible for dry-season persistence of yellow fever, **94** ; yellow fever virus in refrigerated females of, **24** ; used in experiments with yellow fever and monkeys, **59, 60** ; responses of, to visual stimuli, **37** ; rate of blood digestion in, **209, 210** ; breeding places of, **103, 167, 168** ; dry-season breeding of, **168** ; ciliate from Anopheline not infecting larvae of, **90** ; measures preventing breeding of, **103** ; repellents against, **203** ; experiments with insecticides and adults of, **45, 154, 156, 164, 198** ; toxicity of Pyrolan to larvae of, **69** ; use of larvae of, for bioassay of pyrethrins, **62** ; hybridisation experiments with *A. albopictus* and, **119, 120.**

Aëdes africanus, in N. Rhodesia, **167, 168** ; in Uganda, **24, 25, 93, 94, 147, 161** ; and yellow fever, **24, 25, 93, 94, 147, 161, 167** ; experiments with yellow fever and, **24, 25** ; bionomics of, **94, 168.**

Aëdes albopictus, in China, **127** ; in Guam, **103, 189** ; *Toxorhynchites brevipalpis* introduced into Hawaii against, **78** ; relation of, to disease, **127, 189** ; hybridisation experiments with *A. aegypti* and, **119, 120.**

Aëdes caspius, spiracles and humidity requirements of, **84.**

Aëdes chemulpoensis, probable relation of, to encephalitis in China, **127, 128** ; experiments with Japanese B encephalitis and, **127.**

Aëdes cinereus, spiracles and humidity requirements of, **84.**

Aëdes communis, in Canada, **23** ; uptake of radioactive phosphorus from flowers by, **23.**

Aëdes dorsalis, in Canada, **144** ; possible vector of encephalitis in China, **127** ; in U.S.A., **43, 48, 204** ; breeding in rice-fields, **43, 204** ; tests and uses of insecticides against larvae and pupae of, **43, 48, 144, 204** ; DDT-resistance in larvae of, **48.**

Aëdes guamensis, habits of, in Guam, **189.**

Aëdes hexodontus, in Canada, **209** ; rate of blood digestion in, **209.**

Aëdes leucocelaenus, in Brazil, **59** ; bionomics and possible relation to yellow fever of member of complex of, in Panama, **26, 79** ; experiments with yellow fever in monkeys and, **59, 60.**

Aëdes leucotaeniatus, bionomics of, in Panama, **79.**

Aëdes luteocephalus, breeding in tree holes in N. Rhodesia, **167** ; feeding habits of, in Uganda, **94** ; and yellow fever, **94**.
Aëdes nigromaculis (in U.S.A.), breeding and control of, in rice-fields, **204** ; resistance to larvicides in strains of, **48** ; phosphorus compounds against resistant larvae of, **167**.
Aëdes oakleyi, in Guam, **190**.
Aëdes pandani, bionomics of, in Guam, **103, 189** ; aircraft application of DDT against, **103**.
Aëdes polynesiensis, sp.n., vector of *Wuchereria bancrofti* in Polynesia, **161, 162** ; *A. pseudoscutellaris* confused with, **161**.
Aëdes pseudoscutellaris, in Fiji, **161** ; new mosquito recorded as, in other Pacific islands, **161** ; doubtful relation of, to *Wuchereria bancrofti*, **162**.
Aëdes scapularis, possibly ensuring dry-season persistence of yellow fever in Brazil, **59** ; experiments with yellow fever in monkeys and, **59, 60**.
Aëdes schwetzi, dry-season breeding of, in N. Rhodesia, **168**.
Aëdes simpsoni, in N. Rhodesia, **167, 168** ; in Sudan, **190** ; in Uganda, **10, 94, 161** ; bionomics and relation to yellow fever of, **10, 94, 161, 167, 168, 190**.
Aëdes sollicitans, effects of insecticides and irritant vapours on oviposition by, **105, 106** ; repellents against, **203**.
Aëdes taeniorhynchus, repellents against, **203**.
Aëdes togoi, in Okinawa, **188** ; and *Wuchereria bancrofti*, **188**.
Aëdes triseriatus, in U.S.A., **106** ; rearing of, **106**.
Aëdes vexans, in U.S.A., **60, 204** ; Mermithids in larvae of, **60** ; breeding and control of, in rice-fields, **204**.
Aëdes vexans nocturnus, bionomics of, in Guam, **103, 189** ; probable vector of Japanese B encephalitis, **189** ; measures against, **103**.
Aëdes vinsoni, sp.n., in Mauritius, **146**.
Aëdes vittatus, breeding place of, in N. Rhodesia, **168** ; ecology of, in Uganda, **94** ; and yellow fever, **94**.
aegypti, Aëdes.
Aerobacter aerogenes, in *Musca domestica*, **188**.
Aerosols, application of, from aircraft, **54, 72, 73, 151, 152, 202, 211, 212** ; ground applications of, outdoors, **24, 52, 127, 143, 149, 172, 173** ; ineffective for treating calves against *Hypoderma* larvae, **101** ; against insects in aircraft, **150, 151, 201, 204** ; other uses and tests of insecticides as, **10, 31, 65, 70, 82, 137, 149, 204** ; droplet size of, **54, 151** ; equipment for applying, **31, 52, 149** ; resulting from vaporisation of DDT, **76** ; repellents applied to clothing as, **203**.
Africa (see Ethiopian Region).
Africa, French Equatorial, *Simulium damnosum* in, **202** ; ticks and blood parasites of animals in, **169**.
Africa, French West, Anophelines and malaria in, **114-116, 181** ; ticks and blood parasites of animals in, **169, 193**.
Africa, South, blowflies infesting sheep in, **68** ; *Cnemidocoptes* on canaries in, **194**.
africana, Mansonia (*Mansonioides*, *Taeniorhynchus*).
africanus, Aëdes (*Stegomyia*) ; *Phlebotomus*.
Agamofilaria streptocerca (see *Dipetalonema*).
agilis, Laelaps (see *L. muris*).
Agrocide 3, **130**.
Agrocide 7, **130**.
Aircraft, applications of insectides from : against *Culicoides*, **136, 137** ; against *Glossina*, **211, 212** ; against mosquitos and mosquito larvae, **23, 24, 30, 41, 42, 43, 54-56, 72, 73, 103, 151, 152, 167, 172, 204** ; against Simuliids, **41, 42** ; equipment for applying insecticides from, **41, 42, 54, 55, 56, 141** ; types of, for applying insecticides, **149** ; bulletin on use of, for mosquito control, **30** ; carriage and control of insects in, **150, 151, 200, 201, 204**. (See Helicopters.)
akamushi, Trombicula.
albiceps, Chrysomyia.
albimanus, Anopheles.
albipictus, Dermacentor.
albitarsis, Anopheles (*Nyssorhynchus*).
albivirgulatum, Simulium.
albopictus, Aëdes.
alcocki, Simulium.
Aldrin, against *Argas persicus*, **46** ; against larvae of *Culicoides*, **136** ; toxicity of, to fleas, **87, 156, 157** ; against mosquitos or mosquito larvae, **31, 48, 144, 154, 156** ; mosquitos not activated by, **154** ; effect of, on oviposition by *Aëdes sollicitans*, **105** ; acquired resistance to, in mosquito larvae, **48** ; toxicity of, to pupae of mosquitos, **144** ; toxicity of, to *Musca domestica*, **150, 156** ; responses of *M. domestica* to vapours of, **44** ; reactions of strains of *M. domestica* to, **82, 122,**

135, 137 ; effect of using, against larvae of *M. domestica*, **135** ; susceptibility of strains of *Pediculus humanus* to, **106, 156, 157, 159** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157** ; in emulsified solutions, **136, 144** ; in acetone-water suspension, **48** ; specifications for water-dispersible powders of, **31** ; use of heat-liquefied, **150** ; in dusts, **87** ; in sprays, **46, 136** ; deposits of, **46, 82, 137, 150, 154, 156** ; chemical definitions of, **2, 144** (note).
alexandri, *Phlebotomus*.
Algae, Anopheline larvae associated with, **93**.
Algeria, form of *Culex pipiens* in, **207** ; *Ornithodoros erraticus* and relapsing fever in, **193**.
algeriensis, *Anopheles*.
Allethrin, against mosquitos, **31, 45, 156, 178** ; against *Musca domestica*, **71, 72, 101, 124, 125, 135, 156, 204** ; susceptibility of strains of *Pediculus h. humanus* to, **106, 156, 157, 159** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157, 178** ; in aerosols, **204** ; in dusts, **106** ; in sprays, **45, 71, 72, 101, 124, 125, 135** ; effect of test method on relative toxicity of pyrethrins and, in fly-sprays, **135** ; and DDT, **204** ; and pyrethrins, **106** ; synergists with, **71, 72, 101, 204** ; chemical definition of, **2** ; new test for, **64** ; insecticidal activity of isomeric constituents of, **71, 72, 125**.
Allethrolone (*dl*-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one), insecticidal activities of esters of, other than allethrin (*q.v.*), **71, 72, 124, 125** ; piperonyl butoxide with esters of, **72**.
Alouatta, yellow fever in, in Ecuador, **171** ; experiments with yellow fever and Brazilian species of, **59**.
alternata, *Psychoda*.
Aluminium, adherence to, of different DDT deposits, **151**.
Amblyomma americanum, on cattle in U.S.A., **51** ; Q fever not found in, **51**.
America, key to females of *Phlebotomus* of, **112**.
americana, *Periplaneta* (*Blatta*).
americanum, *Amblyomma*.
amictus, *Anopheles*.
Ammonia, stimulating oviposition of insects, **105**.
α-Amylcinnamaldehyde, as repellent against Anophelines, **202**.
N-Amylsuccinimide, as repellent against Anophelines, **202, 203**.
anatolicum, *Hyalomma*.
andersoni, *Dermacentor*.
annulatus, *Boophilus*.
annulipes, *Anopheles*.
annulirostris, *Culex*.
anomalus, *Hoplopsyllus*.
Anopheles, keys to common species of, in French West Africa, **116** ; of Argentina, **92** ; relation of subgenera of, to malaria in Brazil, **56, 57** ; of China and Formosa, **49** ; of Indo-Australian Region, **191** ; of Madagascar, **190** ; of Mexico, **168** ; in Panama, **26** ; flight-range of, **92** ; maxillary indices of, **115** ; resting outdoors, **56, 91, 92, 115, 116, 117, 162, 173** ; larvicides against, **54** ; factors affecting tests of larvicides against, **41** ; review of measures against, **190** ; methods of naming members of complexes of, **116, 117** (and note) ; systematic status of subgenera of, **191** ; (*Kerteszia*) distribution of breeding of, in bromeliads, **15**.
Anopheles aconitus, adult habits of, in Malaya, **162**.
Anopheles albimanus, in Florida, **131** ; in Guatemala, **80** ; in Panama, **56, 131, 202** ; in Porto Rico, **91, 92** ; and malaria, **91** ; experiments with strains of *Plasmodium falciparum* and, **56, 131** ; experiments with *P. praecox* and, **203** ; bionomics of, **80, 91, 92** ; repellents against, **202**.
Anopheles albitarsis, adult habits of, in Trinidad, **211**.
Anopheles albitarsis domesticus, and malaria in Brazil, **56, 57, 92** ; bionomics of, **92** ; DDT against, **57, 92**.
Anopheles algeriensis, in Montenegro, **93** ; spiracles and humidity requirements of, **84** ; avoidance of water surface by larvae of, **205**.
Anopheles amictus, and malaria in Australia, **9**.
Anopheles amictus amictus, **9**.
Anopheles amictus hilli, **9**.
Anopheles annulipes, and malaria in Australia, **9**.
Anopheles aquasalis, in Brazil, **56, 57** ; in Trinidad, **118, 203, 211** ; and malaria, **56** ; adult habits of, **118, 211** ; rate of blood digestion in, **210** ; DDT house-spraying against, **57** ; repellents against, **203**.
Anopheles argyritarsis, breeding places of, in Guatemala, **80**.
Anopheles bancrofti bancrofti, in Australia, **9**.
Anopheles barbirostris, in Malaya, **162**.

Anopheles bellator, and malaria in Brazil, **57** ; in Trinidad, **15, 16** ; bionomics of, **15, 16, 57** ; measures against, **57.**
Anopheles berghei, sp.n., in Belgian Congo, **17.**
Anopheles bifurcatus, auct. (see *A. claviger*).
Anopheles christyi, variability of, **212.**
Anopheles claviger, in Italy, **205** ; in Montenegro, **93** ; in Sardinia, **205, 206** ; spiracles and humidity requirements of, **84** ; avoidance of water surface by larvae of, **205, 206** ; inherent resistance to DDT in larvae of, **205.**
Anopheles concolor, habits of, in Belgian Congo, **17** ; immature stages of, **17.**
Anopheles costalimai (see *A. mediopunctatus*).
Anopheles coustani, in N. Rhodesia, **167** ; relation of complexes of *A. hyrcanus* and, **117.**
Anopheles crawfordi (see *A. hyrcanus crawfordi*).
Anopheles crucians, distribution and breeding places of, in Central America, **80** ; experiments with *Plasmodium praecox* and, **89, 203.**
Anopheles cruzii, and malaria in Brazil, **57** ; bionomics and control of, **57.**
Anopheles cruzii laneanus, status of, **191.**
Anopheles darlingi, in Brazil, **56, 57** ; and malaria, **56** ; selection of oviposition sites by, **60, 61** ; DDT housespraying against, **57.**
Anopheles dureni, habits and possible races of, in Belgian Congo, **17.**
Anopheles elutus (see *A. maculipennis sacharovi*).
Anopheles farauti, and malaria in Australia, **10.**
Anopheles fluminensis, synonymy of, **92.**
Anopheles freeborni (see *A. maculipennis freeborni*).
Anopheles funestus, in French West Africa, **115, 181** ; in Kenya, **153** ; in Liberia, **53** ; and malaria, **53, 115, 181** ; insecticide deposits against, in houses, **153, 154.**
Anopheles gambiae, in French West Africa, **114-116, 181** ; formerly in Brazil, **116** ; in Belgian Congo, **99** ; in Gambia, **116** ; in Kenya, **153** ; in Liberia, **53** ; in Nigeria, **115** ; experiments with *Acanthocheilonema perstans* and, **99** ; and malaria, **53, 115, 116, 181** ; transmitting *Wuchereria bancrofti*, **53** ; bionomics of, **53, 114-116** ; varieties and biological races of, **114, 115, 116** ; insecticide deposits against, in houses, **153, 154** ; reactions of, to insecticide deposits, **153, 154, 155** ; repellents against, **203.**
Anopheles gambiae melas, in French West Africa, **115, 181** ; in Liberia, **53** ; and malaria, **181** ; bionomics of, **115** ; repellents against, **203** ; character and status of, **115.**
Anopheles grabhami, resting places of, in Porto Rico, **92.**
Anopheles guarao, sp.n., in Venezuela, **32.**
Anopheles hancocki, in Liberia, **53.**
Anopheles hectoris, breeding places of, in Guatemala, **80.**
Anopheles hispaniola, in Sardinia, **205, 206** ; avoidance of water surface by larvae of, **205, 206.**
Anopheles holmbergi (see *A. fluminensis*).
Anopheles hyrcanus, adult habits of, in Malaya, **162** ; in Montenegro, **93** ; spiracles and humidity requirements of, **84** ; classification, biology and relation to disease of members of complex of, in south-east Asia, **116-118.**
Anopheles hyrcanus argyropus, in Malaya, **116.**
Anopheles hyrcanus crawfordi, in Malaya, **116, 118** ; experimentally infected with *Wuchereria malayi*, **118** ; described as new species, **116.**
Anopheles hyrcanus D2, in Malaya, **117, 118** ; possibly infected with *Wuchereria malayi*, **118.**
Anopheles hyrcanus indiensis, in Malaya, **116, 117, 118** ; experimentally infected with *Wuchereria malayi*, **118** ; habits of, **117.**
Anopheles hyrcanus lesteri, in Malaya, **116, 117, 118** ; in Philippines, **117** ; relation of, to *Wuchereria malayi*, **118** ; habits of, **117.**
Anopheles hyrcanus nigerrimus, in Borneo, **118** ; in Malaya, **116, 117, 118** ; and malaria, **117** ; natural and experimental infection of, with *Wuchereria malayi*, **118** ; breeding places of, **117.**
Anopheles hyrcanus peditaeniatus, in Malaya, **116, 117, 118** ; experimentally infected with *Wuchereria malayi*, **118** ; breeding in rice-fields, **117.**
Anopheles hyrcanus pseudosinensis, in Philippines, **117.**
Anopheles hyrcanus sinensis, in China, **113, 114, 117, 127** ; in Hong Kong, **94** ; in Malaya, **116, 117** ; in Okinawa, **188** ; and encephalitis, **127, 188** ; and malaria, **94, 113, 114, 117, 188** ; and *Wuchereria* spp., **94, 117, 118, 188** ; bionomics of, **94, 113, 114, 117, 188** ; oriental and palaearctic forms of, **117.**
Anopheles hyrcanus X (see *A. h. nigerrimus*).

Anopheles implexus, habits of, in Belgian Congo, **17.**
Anopheles jeyporiensis var. *candidiensis*, in Hong Kong, **94** ; relation of, to malaria and *Wuchereria bancrofti*, **94** ; breeding in rice-fields, **94.**
Anopheles karwari, in Malaya, **162.**
Anopheles kochi, in Malaya, **162.**
Anopheles laneanus (see *A. cruzi laneanus*).
Anopheles letifer, and malaria in Malaya, **58** ; DDT barrier spray against, **58.**
Anopheles leucosphyrus, distribution, varieties, and relation to malaria of, **57, 58.**
Anopheles leucosphyrus var. *hackeri*, and malaria in Celebes, **58.**
Anopheles lindesayi, spiracles and humidity requirements of, **84.**
Anopheles maculatus, in Hong Kong, **94** ; in Malaya, **58, 162** ; and malaria, **58, 94, 162** ; vector of *Wuchereria bancrofti*, **94** ; adult habits of, **94, 162** ; DDT barrier spray against, **58.**
Anopheles maculipennis, sens. lat., bionomics of, transmitting malaria in Montenegro, **93** ; physiology of hibernation of, **163** ; results of crossing members of complex of, **120.**
Anopheles maculipennis atroparvus, in Italy, **30, 146** ; rate of blood digestion in, **210** ; chromosome pattern of larvae of, **30** ; crossing of other forms of *A. maculipennis* with, **30** ; *A. m. fallax* considered probably identical with, **93.**
Anopheles maculipennis aztecus, and malaria in Mexico, **206** ; reactions to heat of immature stages of, **145** ; control of, by DDT, **206.**
Anopheles maculipennis elutus (see *A. m. sacharovi*).
Anopheles maculipennis fallax, in Montenegro, **93** ; considered probably identical with *A. m. atroparvus*, **93.**
Anopheles maculipennis freeborni, in U.S.A., **90, 131, 204** ; and malaria, **90** ; experiments with *Plasmodium vivax* and, **90** ; experiments with parasites of avian malaria and, **170, 203** ; hibernating in nests of *Neotoma*, **131** ; reactions to heat of immature stages of, **145** ; breeding and control of, in rice-fields, **204** ; repellents against, **202.**
Anopheles maculipennis labranchiae, in Italy, **30** ; in Montenegro, **93** ; control of, by DDT in Sardinia, **205** ; avoidance of water surface by larvae of, **205** ; chromosome pattern of larvae of, **30** ; crossing of *A. m. atroparvus* with, **30.**
Anopheles maculipennis maculipennis (see *A. m. typicus*).
Anopheles maculipennis messeae, in Italy, **30, 146** ; in Yugoslavia, **93, 163, 164**; spiracles and humidity requirements of, **84** ; hibernation of, **163, 164** ; chromosome pattern of larvae of, **30.**
Anopheles maculipennis sacharovi, in Italy, **30, 146** ; in Montenegro, **93** ; and malaria, **146** ; spiracles and humidity requirements of, **84** ; breeding places and control of, **146** ; chromosome pattern of larvae of, **30.**
Anopheles maculipennis subalpinus, in Montenegro, **93.**
Anopheles maculipennis typicus, in Italy, **30, 146** ; in Yugoslavia, **93, 163, 164** ; over-wintering habits of, **163, 164** ; chromosome pattern of larvae of, **30** ; crossing of *A. m. atroparvus* with, **30.**
Anopheles marteri var. *sogdianus*, spiracles and humidity requirements of, **84.**
Anopheles mediopunctatus, synonymy of, **191.**
Anopheles melas (see *A. gambiae* var. *melas*).
Anopheles minimus, in Assam, **10-12** ; in China, **58, 113** ; in Hong Kong, **94** ; and malaria, **11, 58, 94, 113** ; vector of *Wuchereria bancrofti*, **94** ; feeding habits of, **113** ; insecticides against, in houses, **10-12** ; larvicides against, **12.**
Anopheles minimus flavirostris, in Philippines, **172, 173** ; uses of DDT against, **172, 173.**
Anopheles moucheti, experiments with *Acanthocheilonema perstans* and, in Belgian Congo, **99.**
Anopheles neomaculipalpus, adult habits of, in Trinidad, **211.**
Anopheles nili, in Liberia, **53.**
Anopheles paludis, experiments with *Acanthocheilonema perstans* and, in Belgian Congo, **99.**
Anopheles philippinensis, adult habits of, in Malaya, **162.**
Anopheles plumbeus, in Montenegro, **93** ; spiracles and humidity requirements of, **84.**
Anopheles pseudopunctipennis, in South America, **89, 90, 96** ; in Mexico, **80, 88, 128, 131** ; and malaria, **80, 88, 90, 96, 128, 131** ; adult habits of, **88, 89, 90** ; DDT and BHC against, in houses, **80, 88, 128** ; possible difference in relation to malaria of varieties of, **90** ; new subspecies of, **96.**
Anopheles pseudopunctipennis neghmei, subsp. n., habits of, in Chile, **96.**
Anopheles pseudopunctipennis noei, subsp. n., habits of, in Chile, **96.**

Anopheles pseudopunctipennis pseudopunctipennis, and malaria in Mexico, **131** ; DDT against, in buildings, **131**.
Anopheles pulcherrimus, adaptation of spiracles of, to low humidity, **84**.
Anopheles punctipennis, breeding places of, in U.S.A., **49** ; repellents against, **202**.
Anopheles punctulatus moluccensis (see *A. farauti*).
Anopheles quadrimaculatus, in U.S.A., **49, 54, 55, 56, 72, 73, 88, 89, 90, 144, 151, 152** ; and malaria, **90** ; experiment with parasites of human malaria and, **90, 131** ; experiments with avian malaria parasites and, **89, 170, 203** ; breeding places of, **49** ; ciliate destroying larvae of, **90** ; reactions to heat of immature stages of, **145** ; aircraft application of DDT against larvae of, **54-56, 72, 73, 151, 152** ; toxicity of DDT to larvae of, **205** ; DDT deposits against adults of, **53, 88, 89, 152, 155** ; question of resistance to DDT in, **72, 73, 152** ; experiments with other insecticides and, **45, 155, 178** ; reactions of, to insecticide deposits, **152, 155** ; technique of topical application of insecticides to, **178** ; effects on, of dusting against cotton pests, **144** ; tests of repellents against, **72, 202, 203** ; traps and resting stations for measuring populations of, **56**.
Anopheles rodhaini, sp.n., ecology of, in Belgian Congo, **30** ; characters of, **30, 112**.
Anopheles rufipes, relation of, to malaria in French West Africa, **181**.
Anopheles smithii, breeding places of, in Liberia, **53**.
Anopheles stephensi, experiments with insecticide deposits and, **154, 155, 198**.
Anopheles subpictus, **103** ; ammonia stimulating oviposition by, **105**.
Anopheles subpictus indefinitus, in Guam, **189** ; inefficient vector of malaria, **189**.
Anopheles sundaicus, and malaria in Malaya, **58** ; DDT barrier spray against, **58**.
Anopheles superpictus, bionomics and control of, transmitting malaria in Montenegro, **93** ; adaptation of spiracles of, to low humidity, **84**.
Anopheles tessellatus, in Malaya, **162**.
Anopheles vagus, DDT and BHC against, in houses in Assam, **11** ; adult habits of, in Malaya, **162**.
Anopheles vanhoofi, ecology of, in Belgian Congo, **30**.
anserina, Spirochaeta (*Borrelia*).
Antelope, *Anopheles gambiae* feeding on, **115**.
antennatus, Phlebotomus.
Aphis rumicis, toxicity of Pyrolan to, **69**.
apicalis, Culex.
Apodemus, Trombicula akamushi on, in Japan, **194**.
appendiculatus, Rhipicephalus.
Apus, DDT against, in rice-fields in California, **43**.
aquasalis, Anopheles (*Nyssorhynchus*).
arachnovora, Eurytoma.
Aramite (see 2-Chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl Sulphite).
Ardea cinerea, Argas persicus associated with, in Pakistan, **210**.
Argas persicus, associated with wild birds on trees in Pakistan, **210** ; treatment against, on fowls in U.S.A., **46, 47** ; experiment with *Spirochaeta duttoni* and, **97, 98** ; toxicity of Diazinon to, **198, 199**.
Argentina, mosquitos of, **92**.
argentipes, Phlebotomus.
argyritarsis, Anopheles.
argyromeris, Haemagogus.
argyropus, Anopheles hyrcanus.
Aroclor 5460, lindane deposits improved by, **143**.
arpaklensis, Phlebotomus minutus (see *P. dentatus*).
Arribalzagia (subgenus of *Anopheles*), *Shannoniella* not distinct from, **191**.
Arsenic, in dips against *Boophilus annulatus*, **16** ; strain of *B. a. microplus* resistant to, **180**.
Arvicola terrestris, relation of mites to tularaemia in, in U.S.S.R., **184, 185**.
Asia, Trombiculids of, **212**. (See Oriental Region.)
Ateles, yellow fever in, in Ecuador, **171**.
Atherosperma moschatum, essential oil from, as synergist for pyrethrum, **165**.
Atomised Sprays, insecticides applied from aircraft as, against mosquitos or mosquito larvae, **22, 23, 30, 41, 54-56, 57, 72, 73, 151, 152** ; against Simuliids, **41, 42** ; equipment for applying, from aeroplanes and helicopters, **41, 141** ; other uses of, against mosquitos, **10, 11** ; against *Musca domestica*, **137** ; equipment for ground application of, **31, 149** ; laboratory tests of insecticides in, against *M. domestica* or mosquitos, **45, 71, 72, 74, 82, 101, 107, 124, 125, 135, 137, 164, 165, 166** ; methods and equipment for laboratory tests of, **135, 141, 142, 198** ; definitions and effects of droplet size of, **55, 139, 142, 151, 152** ; use of, to apply toxic deposits, **138**.

atroparvus, *Anopheles maculipennis*.
aureum, *Simulium*.
austeni, *Culicoides*.
Austral Islands, new mosquito recorded as *Aëdes pseudoscutellaris* in, **162**.
Australasia, Anophelines of, **191** ; Trombiculids of, **212**.
australasiae, *Periplaneta*.
Australia, Anophelines and malaria in, **9, 10**; pests of sheep and cattle in, **65, 180, 195-197** ; book on pests of livestock in, **112**.
Australian Plants, pyrethrum adjuvants derived from, **165**.
Autographa gamma, experiment with Pyrolan and, **69**.
aztecus, *Anopheles maculipennis*.

B

Backhousia myrtifolia, essential oil from, as synergist for pyrethrum, **165**.
bacoti, *Bdellonyssus* (*Liponyssus*).
baduelensis, *Phlebotomus*.
Baits, insecticides in, against *Musca domestica*, **145, 171**.
Bamboo Pots, used to study breeding of mosquitos, **168**.
Bamboos, mosquito breeding in, **170**.
bancrofti, *Anopheles* ; *Wuchereria* (*Filaria*).
barbirostris, *Anopheles*.
Barbituric Acid, antagonistic action of Pyrolan and, **70**.
Bats, Anophelines and malaria of, in Belgian Congo, **30**.
Bdellonyssus bacoti, in Britain, **8** ; in U.S.A., **32** ; attacking man, **8** ; on rats, **8, 32** ; experiments with filaria of cotton rats and, **7, 12, 33, 51** ; experimental transmission of tularaemia by, **200** ; rate of blood digestion in, **210** ; humidity chamber for maintaining, **51** ; differentiation of sexes and stages of, **33**.
Bdellonyssus sylviarum (see *Fonsecaonyssus*).
Bechuanaland, yellow fever in, **24**.
Bed-bug (see *Cimex*).
Bees, toxicity of Pyrolan to, **69**.
bellator, *Anopheles* (*Kerteszia*).
Benign Tertian Malaria (see *Plasmodium vivax*).
Benzene Hexachloride (see BHC).
Benzyl Benzoate, against *Dermatophagoides*, **34** ; as repellent against fleas and Trombiculids, **203** ; in all-purpose repellent mixture for treating clothing, **203**.
Benzyl Salicylate, against *Dermatophagoides*, **34**.
berbericus, *Culex pipiens*.
berghei, *Anopheles*.
BHC, against *Culicoides*, **136** ; against mosquitos, **10, 11, 31, 57, 128, 153, 154, 155, 156, 178** ; effect on mosquitos of using, against cotton pests, **144** ; effect of, on oviposition by *Aëdes sollicitans*, **105** ; against mosquito larvae, **12, 48, 54** ; acquired resistance to, in mosquito larvae, **48** ; against Simuliid larvae, **202** ; against *Glossina palpalis*, **211** ; against *Musca domestica*, **44, 121, 123, 137, 150, 156, 171, 175** ; resistance of strains of *M. domestica* to, **74, 75, 82, 121, 122, 123, 124, 136, 137, 138, 159, 171, 174, 175, 179, 199** ; toxicity of, to larvae of *M. domestica*, **36** ; resistance to, in larvae of *M. domestica*, **136** ; reactions of strains of *Drosophila* to, **37, 38, 157, 158** ; against sheep blowflies, **65, 196** ; other tests of, against blowfly larvae, **36, 96** ; against *Dermatobia hominis*, **35, 36, 96, 109, 182, 197**; against *Hypoderma*, **23** ; against *Cimex lectularius*, **69, 156** ; against cockroaches, **42, 143** ; strains of *Blattella germanica* resistant to, **139, 179** ; against fleas, **87, 156, 157** ; against *Pediculus h. humanus*, **157** ; toxicity of, to strains of *P. h. humanus*, **106, 156, 157, 159** ; against lice and mites on fowls or pigeons, **46, 102, 108** ; against ticks, **46, 47, 130, 156, 195** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157, 178** ; solutions of, **10, 11, 12, 36, 38, 121, 143, 156, 157, 211** ; emulsions of solutions of, **10, 11, 23, 31, 37, 54, 136, 171, 197, 211** ; in wettable-powder suspensions, **10, 11, 31, 44, 54, 128, 153, 154, 155, 157, 171, 182** ; in acetone-water suspension, **48** ; in oil-bound suspension concentrate, **153** ; comparison of formulations of, **153** ; in aerosols, **137, 196, 211** ; in dips, **35, 195** ; in dusts, **35, 46, 87, 96, 102, 106, 130, 144, 157, 182, 197, 202** ; in sprays, **10, 23, 42, 46, 54, 65, 69, 137, 171, 182, 196, 197, 211** ; applied from aircraft, **57, 211** ; applied by continuous vaporisation, **42, 108, 109, 175** ; use of heat-liquefied, **150** ; dressings and ointments containing, **35, 96, 109, 182, 197** ; internal treatment of animals with, **36** ; in poison bait, **171** ; effectiveness of deposits of, on treated surfaces, **10, 11, 38, 44, 46, 82, 121, 123, 128,**

143, 150, 153, 154, 155, 156, 157, 171, 175 ; effect of type of surface on toxicity of, **157** ; probable action of air-borne particles from deposits of, **154** ; fumigant action of, **44, 153, 154, 196** ; question of repellent action of, **42, 44, 128** ; duration of effectiveness of, in water, **54** ; effects of, on birds and fish, **54, 102, 108, 109** ; chlorinated polyphenyl improving deposits of, **143** ; and DDT, **144, 153** ; and methoxy-DDT, **175** ; and sulphur, **144** ; and TEPP, **171** ; and toxaphene, **182** ; synergist with, **138, 175** ; bioassay of, **48, 108** ; other methods of determination and analysis of, **48** ; as lindane, **3, 31, 35, 42, 44, 46, 47, 48, 74, 75, 102, 106, 108, 109, 136, 137, 138, 143, 150, 171, 174, 175, 178, 179, 197** ; γ isomer of, **2, 3, 10, 11, 31, 35, 36, 37, 38, 42, 44, 46, 48, 54, 65, 82, 87, 96, 102, 106, 108, 109, 121, 122, 123, 128, 130, 136, 137, 139, 143, 150, 153, 156, 157, 158, 159, 171, 174, 175, 179, 182, 195, 196, 197, 202, 211** ; specifications for, **31** ; application of name and citation of isomers of, **2.**

cis-Bicyclo[2.2.1]-5-heptene-2, 3-dicarboxylic Acid, dimethyl ester of (see Dimethyl Carbate).

bifurcatus, auct., *Anopheles* (see *A. claviger*).

Bioassay, of insecticides, **13, 48, 62, 70, 108.**

Birds, species of *Cnemidocoptes* infesting, **194, 195** ; *Dermanyssus gallinae* in nests of, **109** ; *Hyalomma marginatum* on, **19** ; *Phlebotomus* breeding in underground nests of, **19** ; as hosts of *Trombicula akamushi* and *T. deliensis*, **193, 194** ; experiments with mosquitos and malaria of, **89, 169, 170, 203** ; effect of lindane vapour on, **108.**

Bis(bis(dimethylamino))phosphonous Anhydride (see Schradan).

1,1-Bis(p-bromophenyl)-2,2,2-trichloroethane (see Bromo-DDT).

Bis(p-chlorophenoxy)methane, uses of, against mite on fowls, **102.**

Bis(p-chlorophenyl) Acetic Acid (see DDA).

Bis(p-chlorophenyl)chloromethane, effect of, with DDT or methoxy-DDT against *Musca domestica*, **74, 75.**

1,1-Bis(p-chlorophenyl)-2,2-dichloroethane (see DDD).

1,1-Bis(p-chlorophenyl)-2,2-dichloroethylene (see DDE).

1,1-Bis(chlorophenyl)ethane, as synergist for DDT against *Musca domestica*, **74, 75, 138, 175, 206** ; with methoxy-DDT, **75** ; p,p′ isomer of, **74, 206.**

1,1-Bis(p-chlorophenyl)ethanol (see Bis-(p-chlorophenyl) Methyl Carbinol).

Bis(p-chlorophenyl) Ethynyl Carbinol, effect of, with DDT or methoxy-DDT against *Musca domestica*, **74, 75.**

Bis(p-chlorophenyl) Methyl Carbinol (DMC), not effective against *Fonsecaonyssus sylviarum*, **102** ; as synergist for DDT against *Musca domestica*, **74, 206.**

1,1-Bis(p-chlorophenyl)-2-nitrobutane, mixture containing (see Dilan).

1,1-Bis(p-chlorophenyl)-2-nitropropane, mixture containing (see Dilan).

1,1-Bis(p-chlorophenyl)-2,2,2-trichloroethane (see DDT).

Bisdimethylaminophosphonous Anhydride (see Schradan).

Bisethylxanthogen (see Dixanthogen).

1,1-Bis(p-fluorophenyl)-2,2,2-trichloroethane (see Fluoro-DDT).

bishoppi, *Hippelates*.

1,1-Bis(p-methoxyphenyl)-2,2,2-trichloroethane (see Methoxy-DDT).

1,1-Bis(p-methylphenyl)-2,2,2-trichloroethane (see Methyl-DDT).

bispinosa, *Haemaphysalis*.

Blatta americana (see *Periplaneta*).

Blatta orientalis, insecticide treatments against, in U.S.A., **42.**

Blattella germanica, in U.S.A., **42, 179** ; insecticide treatments against, **42** ; occurrence, production and inheritance of insecticide resistance in, **104, 139, 179** ; toxicity of Diazinon to, **198.**

Blowflies, possible relation of, to diseases of man, **82, 83** ; infesting sheep, **65, 68, 196** ; factors affecting infestation of sheep by, **68** ; infesting other domestic animals, **96** ; carriage of, in aircraft, **200** ; attracted by natural gas, **142, 143** ; radioactive tracer studies of dispersal of, **172** ; methods of marking, with radioactive phosphorus, **108, 172, 187**; measures and experiments against, **36, 65, 83, 96, 196** ; physiological effect of DDT on larvae of, **49** ; trap for, **44** ; cage and rearing media for, **109, 145.**

Boophilus annulatus, eradication of, on domestic animals in British Virgin Is., **16.**

Boophilus annulatus microplus (on cattle), in Australia, **180, 181, 195** ; in Nicaragua, **35** ; organic compounds in sprays or dips against, **35, 180, 181, 195** ; arsenic-resistant strain of, **180.**

Borneo, Anophelines in, **57, 58, 118** ; malaria in, **57, 58** ; *Wuchereria malayi* in, **118.**
Borrelia (see *Spirochaeta*).
Bovicola (see *Damalinia*).
bovinus, Tabanus.
bovis, Damalinia (*Bovicola*) ; *Hypoderma* ; *Psoroptes.*
bovis, auct., *Sarcoptes* (see *S. bubulus*).
Bran, in medium for rearing *Musca domestica*, **81.**
brasiliensis, Ornithodoros ; *Spirochaeta* (*Borrelia*).
Brazil, Anophelines and malaria in, **56, 57, 92, 116** ; relation of other mosquitos and monkeys to yellow fever in, **59** ; *Culicoides guttatus* in, **32** ; *Ornithodoros brasiliensis* in, **133, 134** ; new spirochaete in *O. brasiliensis* in, **134** ; *Dermatobia hominis* on cattle in, **35, 36, 96, 182, 197** ; blowflies infesting animals in, **96.**
brevipalpis, Toxorhynchites.
Britain, mosquitos in, **119, 120** ; Simuliids in, **14** ; *Pediculus humanus* in, **159** ; *Bdellonyssus bacoti* on man and rats in, **8** ; new mite on budgerigar in, **194.**
Bromeliads, *Anopheles* spp. breeding in, in Brazil, **57** ; factors affecting breeding of *A. bellator* in, in Trinidad, **15, 16** ; methods of eliminating, **57.**
Bromo-DDT, irritation of mosquitos by deposits of, **155** ; (and p,p′ bromo-DDT), chemical definitions of, **2.**
Bronzing Powder, for marking Anophelines, **92.**
brucei, Trypanosoma.
Budgerigar, new *Cnemidocoptes* on, **194.**
Buffalo, Anophelines feeding on, in China, **113.**
bullata, Sarcophaga.
Burlap, use of DDT-treated, against mosquito larvae in barrels, **103.**
Burma, *Anopheles leucosphyrus* and malaria in, **57, 58** ; Trombiculids and tsutsugamushi disease in, **6.**
burneti, Rickettsia.
α - [2 - (2-Butoxyethoxy) - ethoxy] - 4,5 - methylenedioxy-2-propyltoluene, principal constituent of piperonyl butoxide (*q.v.*), **3.**
N-Butylacetanilide, as repellent against ticks and fleas, **203** ; in all-purpose repellent mixture for treating clothing, **203.**
n-Butyl Carbitol Thiocyanate (β-Butoxy-β′-Thiocyanodiethyl Ether), in aerosol formulations against *Musca domestica*, **204** ; in spray against mosquitos, **10, 11.**
2-Butyl-2-ethyl-1,3-propanediol, as repellent against mosquitos, **203** ; all-purpose repellent mixture containing, **203** ; treatment of clothing with, **203.**
Butyl Mercaptan, blowflies probably attracted by, **143.**
N-Butyl-1,2,3,6-tetrahydrophthalimide, treatment of clothing with, as repellent against mosquitos, **203.**

C

caballi, Sarcoptes.
Cacao, association of *Anopheles bellator* with plantations of, in Trinidad, **16.**
caecutiens, Onchocerca (see *O. volvulus*).
Cage, for flies, **109.**
Calandra granaria, experimentally acquired resistance to pyrethrum in, **165** ; used in tests of pyrethrum synergists, **164** ; toxicity of Pyrolan to, **69.**
calcitrans, Stomoxys.
Calcium Arsenate, ineffective against *Culicoides*, **136.**
Calcium Arsenite, dusting with, against Anopheline larvae, **93.**
callidum, Simulium.
Calliphora erythrocephala, bionomics of, in U.S.S.R., **82, 83.**
Calliphora lilaea, attracted by natural gas in Arizona, **143.**
Calliphora uralensis, bionomics and control of, in U.S.S.R., **82, 83** ; spread of dysentery bacilli and parasitic worms by, **83.**
Callithrix jacchus, infection of mosquitos with yellow fever from, **59.**
Callitroga, attracted by natural gas in Arizona, **143.**
Callitroga macellaria, method of marking, with radioactive phosphorus, **187.**
Callosciurus nigrovittatus, Trombiculid on, in Malaya, **31.**
Camels, Tabanids and *Trypanosoma evansi* in, **118.**
Cameroons, British, *Chrysops* spp. and *Loa loa* in, **27.**
Canada, mosquitos in, **23, 24, 41, 65, 66, 143, 144, 209** ; encephalitis virus in *Culex* spp. in, **66, 209** ; Simuliids in, **23, 24, 41, 209, 210** ; Tabanids in, **23** ; pest Trichoptera in, **52** ; *Dermacentor andersoni* causing paralysis in man in, **45.**
Canaries, *Cnemidocoptes* on, **194** ; used in experiments with avian malaria, **89, 204** ; effect of lindane vapour on, **108.**
candidiensis, Anopheles jeyporiensis.

canestrinii, Ornithodoros.
capillatus, Solenopotes.
capitis, Pediculus humanus.
carinii, Litomosoides.
caspius, Aëdes.
Cattle, Anophelines attracted by, **89, 94, 113, 115, 117, 162** ; other mosquitos attacking, **163** ; Simuliids attacking, **15** ; Tabanids attacking, **28, 45** ; relation of Tabanids to trypanosomiasis of, in Sudan, **118** ; *Hippelates* associated with conjunctivitis in, **40** ; *Dermatobia hominis* infesting, **34, 35, 36, 96, 109, 182, 197** ; *Hypoderma* in, **23, 45, 101, 110** ; lice on, **104, 180** ; clipping of, for control of lice, **104** ; ticks on, **16, 19, 20-22, 35, 51, 66, 67, 77, 84, 180, 195** ; *Theileria parva* in, **20-22** ; and Q fever, **51** ; effects on, of prolonged treatment with DDT, **195** ; internal treatment of, with insecticides, **36** ; insecticides in milk and fat of sprayed, **16** ; rate of development of *Musca domestica* in dung of, **199, 200.**
caucasicus, Phlebotomus.
Cebus, yellow fever in, in Ecuador, **171.**
Cellosolve (see Ethylene Glycol Monoethyl Ether).
centurionis, Chrysops.
Cercocebus, and yellow fever in Uganda, **10.**
Cercopithecus aethiops centralis, relation of *Aëdes africanus* and yellow fever to, in Uganda, **24, 25, 147** ; new spirochaete in, in Kenya, **97.**
cerealella, Sitotroga.
cervicalis, Onchocerca.
Cetylpyridinium Chloride, used in study of reaction of wetting agents with sheep fleece, **129.**
chalcospilans, Haemagogus.
chemulpoensis, Aëdes.
cheopis, Xenopsylla.
Chigger Mites (see Trombiculids).
Chile, *Anopheles pseudopunctipennis* and malaria in, **90, 96** ; new subspecies of *A. pseudopunctipennis* in, **96.**
China, Anophelines in, **49, 58, 113, 114, 117, 127** ; other mosquitos in, **127, 128** ; epidemic encephalitis in, **127, 128** ; malaria in, **49, 58, 113, 114, 117** ; *Wuchereria* spp. in, **117, 118.**
chinensis, Phlebotomus.
Chironomus dorsalis, **172.**
Chlordane, against *Culicoides*, **136** ; against mosquitos, **31, 154, 156, 178** ; mosquitos not activated by, **154** ; effect of, on oviposition by *Aëdes sollicitans*, **105** ; against *Dermatobia hominis*, **35, 36** ; against larvae and adults of blowflies, **36, 196** ; against *Musca domestica*, **44, 60, 121, 123, 126, 137, 150, 171** ; reactions of strains of *M. domestica* to, **60, 82, 121, 122, 123, 124, 126, 135, 136, 137, 159, 171, 199**; effect of using, against larvae of *M. domestica*, **36, 135, 136** ; against *Blattella germanica*, **42** ; strain of *B. germanica* resistant to, **179** ; against fleas, **87, 156, 157** ; toxicity of, to strains of *Pediculus h. humanus*, **106, 156, 157, 159** ; against louse and mite on fowls, **46, 47** ; against ticks, **46, 156, 180** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157, 178** ; question of repellent action of, **42, 44** ; lack of fumigant action of, **44** ; in emulsions, **42, 60, 126, 136, 180** ; specifications for emulsion concentrates of, **31** ; in solutions, **36, 44, 156, 157, 179** ; in wettable-powder suspensions, **44, 171** ; in aerosols, **82** ; in dusts, **42, 47, 87, 102** ; in sprays, **42, 46, 47, 60, 137, 171, 180, 196** ; applied from aircraft, **136** ; use of heat-liquefied, **150** ; in ointments, **35** ; effectiveness of, on treated surfaces, **44, 46, 60, 82, 123, 126, 137, 150, 154, 156, 171** ; internal treatment of animals with, **36** ; chicks killed by, **102** ; and DDT, **60** ; and thanite, **82** ; chemical definition of, **2** ; experiment with α-isomer of, **154.**
Chlorinated Camphene (see Toxaphene).
Chlorinated Polyphenyls, for improving lindane deposits, **143.**
Chlorinated Turpentines, in sprays against *Musca domestica*, **107** ; preparations containing, against parasites of domestic animals, **110.**
o-Chloro-N,N-diethylbenzamide, in repellent mixtures against mosquitos and Simuliids, **72, 201.**
2-Chloroethyl 2-(p-tert.-Butylphenoxy)-1-methylethyl Sulphite, in dust against mite on fowls, **102.**
Chlorophenothane (see DDT).
p-Chlorophenyl p-Chlorobenzenesulphonate, not effective against *Fonsecaonyssus sylviarum*, **102.**
p-Chlorophenyl 1,2-Dichloro-2-(p-chlorophenyl)ethyl Ketone, as synergist for DDT against *Musca domestica*, **206.**
p-Chlorophenyl Phenyl Sulphone, not effective against *Fonsecaonyssus sylviarum*, **102.**
chloropterus, Sabethes (*Sabethoides*).
chloropyga, Chrysomyia.

Cholinesterases, effects of insecticides on, **173, 174, 179, 198.**
Chorioptes equi, on horses in U.S.S.R., **111** ; dixanthogen preparation against, **111.**
christi, *Anopheles* (*Pyretophorus*).
Chrysanthemum Dicarboxylic Acid Monomethyl Ester, insecticidal and synergistic activity of esters of cyclopentenolones and, **71, 72, 125.**
Chrysanthemum Monocarboxylic Acid Esters, of cyclopentenolones, insecticidal and synergistic activities of, **71, 72, 74, 125.** (See also Allethrin and Furethrin.)
Chrysomyia albiceps, a secondary sheep blowfly in South Africa, **68** ; nutrition of larvae of, **68.**
Chrysomyia chloropyga, infesting sheep in South Africa, **68** ; nutrition of larvae of, **68.**
Chrysopa, **107.**
Chrysops, repellent against, in Nigeria, **160.**
Chrysops centurionis, in Uganda, **94.**
Chrysops dimidiata, bionomics of, in Nigeria, **28, 160** ; transmitting *Loa loa*, **28.**
Chrysops langi, attacking man in British Cameroons, **27.**
Chrysops longicornis, in Nigeria, **28, 160** ; breeding places of, **28.**
Chrysops relicta, ovipositing on plants in U.S.S.R., **68.**
Chrysops silacea, bionomics of, in West Africa, **27, 28, 160** ; transmitting *Loa loa*, **27, 28.**
Ciliates, destroying mosquito larvae, **90.**
Cimex hemipterus, experiments with *Spirochaeta duttoni* and, **97, 98.**
Cimex lectularius, in Germany, **13, 68, 69, 149** ; experiments with *Rickettsia burneti* and, **192** ; rate of blood digestion in, **210** ; uses and tests of insecticides against, **13, 69, 149, 156, 198, 199.**
cinereus, *Aëdes*.
Cinerin I, **74, 101** ; toxicity to *Musca domestica* of, alone and with piperonyl butoxide, **72** ; ratio of other active esters of pyrethrum extract to, **72** ; (and isomers), synthesis of, **212** ; allyl homologue of (see Allethrin).
Cinerin II, toxicity to *Musca domestica* of, alone and with piperonyl butoxide, **72** ; ratio of other active esters of pyrethrum extract to, **72.**
Cinerolone, synthesis of isomers and analogues of, **166, 212.**
Citellus beecheyi, fleas on, in U.S.A., **64, 150** ; plague in, **64** ; microclimate of burrows of, **150.**
claviger, *Anopheles*.
Clothes Louse (see *Pediculus humanus humanus*).
Clothing, treatment of, with repellents against blood-sucking arthropods, **203.**
Cnemidocoptes jamaicensis, on thrush in Jamaica, **195.**
Cnemidocoptes mutans, on fowls, **194** ; related mites possibly recorded as, on other birds, **194, 195.**
Cnemidocoptes pilae, sp.n. (on cage birds), in Britain, **194** ; possibly in South Africa, **194, 195.**
Cockroaches, experiments with Coxsackie virus and, **86** ; carriage of, in aircraft, **200** ; measures and experiments against, **42, 76** ; used for tests of toxicity of insecticides, **69, 124, 142, 143, 198** ; occurrence, production and inheritance of insecticide resistance in, **104, 139, 179** ; lipase of, in relation to pyrethrins, **62** ; radioactive tracer study of distribution and metabolism of pyrethrins in, **177, 178.** (See also *Parcoblatta pensylvanica*.)
Cold, strain of *Drosophila* resistant to, **158.**
coli, *Escherichia*.
collusor, *Hippelates*.
Colobus, and yellow fever in Uganda, **10.**
columbaczense, *Simulium* (*Danubiosimulium*).
communis, *Aëdes*.
Compound 118 (see Aldrin).
Compound 269 (see Endrin).
Compound 497 (see Dieldrin).
Compound 711 (see Isodrin).
Compound 3956 (see Toxaphene).
Compound 4049 (see Malathon).
conchobius, *Eretmapodites silvestris*.
concolor, *Anopheles*.
Conepatus, *Ornithodoros brasiliensis* in dens of, in Brazil, **133.**
confusum, *Tribolium*.
Congo, Belgian, mosquitos in, **17, 30, 99** ; *Plasmodium* in bats in, **30** ; Simuliids in, **13, 29, 49, 50, 62, 63, 99, 111, 112, 201, 202** ; *Onchocerca volvulus* in, **13, 29, 111, 201, 202** ; investigations of vectors of *Acanthocheilonema perstans* and *Dipetalonema streptocerca* in, **98-100** ; other filariae in, **98.**
Congress of Entomology, transactions of IXth international, **119-124.**
Conjunctivitis, *Hippelates* associated with, in cattle and man in U.S.A., **40, 87, 88.**

conori, Rickettsia rickettsi.
Cook Islands, new mosquito recorded as *Aëdes pseudoscutellaris* in, **161.**
Copper Sulphate, use of, to destroy bromeliads, **16.**
corporis, Pediculus humanus (see *P. h. humanus*).
costalimai, Anopheles (see *A. mediopunctatus*).
Cotton Pests, DDT-resistance in *Anopheles quadrimaculatus* associated with control of, **73.**
Cotton Rats (see *Sigmodon hispidus*).
Cotton-wool, flies not repelled by tufts of, **47.**
coustani, Anopheles.
Coxsackie Viruses, isolated from flies, **86** ; experiments with *Periplaneta americana* and, **86** ; reviews of data on, **86, 113.**
Crab Louse (see *Phthirus pubis*).
Crabs, attachment of immature stages of Simuliids to, **62, 111.**
crawfordi, Anopheles hyrcanus.
Creosote, ineffective in emulsion against *Culicoides* larvae, **136.**
Cricetulus migratorius, Ornithodoros erraticus transmitting spirochaete of, in Persia, **9.**
Crimean Haemorrhagic Fever, vector and causal agent of, **18, 19, 51.**
Crocidura coerulea, Trombiculids on, in Bengal, **5.**
crocidurae, Spirochaeta (*Borrelia*).
N-Crotonyl-N-ethyl-o-toluidine, in repellent mixture against Simuliids, **201.**
crucians, Anopheles.
cruciatus, Phlebotomus.
cruzi, Trypanosoma.
cruzii, Anopheles (*Kerteszia*).
CS-708 (see Dilan).
Ctenocephalides, hosts of, in Texas, **32.**
Ctenocephalides felis, tests of insecticides against, **87** ; repellent against, **203.**
Cubé, in sprays and washes against *Hypoderma,* **45, 102** ; spray pressure not influencing effectiveness against *Hypoderma* of, **45** ; in dusts and sprays against *Melophagus ovinus,* **73, 139** ; with piperonyl butoxide and pyrethrins, **102** ; and sulphur, **73.**
Culex, use of eggs of, for rearing Trombiculids, **4** ; toxicity of Diazinon to larvae of, **198.**
Culex annulirostris, experimental vector of Japanese B encephalitis, **190.**
Culex annulirostris marianae, bionomics of, in Guam, **189.**
Culex apicalis, breeding places of, in U.S.A., **49.**
Culex gelidus, feeding habits of, in Malaya, **163.**
Culex litoralis, in Guam, **190.**
Culex nebulosus, experiments with *Acanthocheilonema perstans* and, in Belgian Congo, **99, 100.**
Culex perfidiosus, experiments with *Acanthocheilonema perstans* and, in Belgian Congo, **99, 100.**
Culex pipiens, sens. lat., in Algeria, **207** ; in Britain, **119, 120** ; in Egypt, **119, 120, 206, 207** ; in France, **120** ; in Germany, **120** ; Mermithids in larvae of, in U.S.A., **60** ; comparison of allethrin and pyrethrins against, **45** ; sprays against, **45** ; status, bionomics and physiology of forms comprising complex of, **15, 119-121, 206, 207** ; hybridisation and morphology of forms of, **15, 119, 120, 121.**
Culex pipiens berbericus, probably a "molestus" form of *C. pipiens,* **207.**
Culex pipiens fatigans, not found in Egypt, **207** ; in Guam, **103, 189** ; in Kenya, **153** ; in Malaya, **162, 163** ; in Okinawa, **188, 189** ; in U.S.A., **15** ; experiments with *Acanthocheilonema perstans* and, **99, 100** ; experiments with Japanese B encephalitis and, **31, 58, 186, 190** ; vector of *Wuchereria bancrofti,* **188, 189** ; adult habits of, **60, 61, 162, 163, 189** ; other bionomics of, **36, 119** ; ciliate from *Anopheles quadrimaculatus* not infecting larvae of, **90** ; toxicity to, of insecticide deposits in houses, **153** ; control of, by sanitation, **103** ; status and morphology of, **15, 119** ; hybridisation of, with other forms of *C. pipiens,* **15, 119.**
Culex pipiens molestus, possibly in Algeria, **207** ; in Britain, **119, 120** ; in Egypt, **119, 207** ; in France, **119, 120** ; in Germany, **120** ; bionomics and physiology of, **119, 120, 206, 207, 210** ; characters and status of, **119, 207** ; hybridisation of, with other forms of *C. pipiens,* **119** ; varying reproductive compatibility of strains of, **119, 120** ; experiments with insecticide deposits and, **155, 198.**
Culex pipiens pallens, possible relation of, to encephalitis in China, **127, 128** ; experiments with Japanese B encephalitis and, **127.**
Culex pipiens pipiens, in U.S.A., **15** ; used in experiments with avian malaria, **89** ; characters and status of, **15, 119** ; hybridisation of, with other forms of *C. pipiens,* **15, 119.**
Culex quinquefasciatus, auct. (see *C. pipiens fatigans*).

Culex restuans, encephalitis virus in, in Manitoba, **209.**
Culex salinarius, Mermithids in larvae of, in U.S.A., **60.**
Culex sinensis, feeding habits of, in Malaya, **163** ; in Okinawa, **188** ; and *Wuchereria bancrofti*, **188.**
Culex tarsalis, in Canada, **65, 66** ; in U.S.A., **48, 65, 66, 127, 167, 204** ; relation of, to encephalitis viruses, **65, 66, 127** ; bionomics of, **66, 127, 204** ; resistance to larvicides in strains of, **48** ; phosphorus compounds against resistant larvae of, **167** ; other measures against, **127, 204.**
Culex tritaeniorhynchus, possible vector of encephalitis in China, **127** ; in Okinawa, **188** ; and *Wuchereria bancrofti*, **188.**
Culex vishnui, feeding habits of, in Malaya, **163** ; in Okinawa, **188** ; and *Wuchereria bancrofti*, **188.**
Culicoides, caught in light-traps in Porto Rico, **76** ; of Sakhalin, **83** ; relation of, to filariae of man and animals, **86, 98, 99, 100** ; repellent against, **86.**
Culicoides austeni, believed not to transmit *Acanthocheilonema perstans*, **99.**
Culicoides diabolicus (see *C. guttatus*).
Culicoides filariferus (see *C. guttatus*).
Culicoides furens, breeding places and control of, in Florida, **136** ; believed not to transmit *Mansonella ozzardi*, **99.**
Culicoides gibsoni, sp.n., attacking man in Guatemala, **85, 86** ; experiments with *Onchocerca volvulus* and, **86.**
Culicoides grahami, in Belgian Congo, **99** ; not ingesting microfilariae of *Acanthocheilonema perstans*, **99** ; development of *Dipetalonema streptocerca* in, **99.**
Culicoides guttatus, attacking man in Guatemala, **86** ; experiments with *Onchocerca volvulus* and, **86** ; distribution and synonymy of, **32, 86.**
Culicoides inamollae, light-trap studies of, in Porto Rico, **76.**
Culicoides insignis (see *C. guttatus*).
Culicoides melleus, breeding places of, in Florida, **137.**
Culicoides nubeculosus, bionomics of, in France, **100** ; relation of, to *Onchocerca* of horses, **100** ; rate of blood digestion in, **210.**
Culicoides paraensis, attacking man in Guatemala, **86** ; experiments with *Onchocerca volvulus* and, **86.**
Culicoides stigmalis, sp.n., attacking man in Guatemala, **85, 86** ; in Panama, **85** ; experiments with *Onchocerca volvulus* and, **86.**
cuprina, Lucilia.
cyaneus, Sabethes.
2-Cyclohexyl-4,6-dinitrophenol (see Dinex).
Cyclopropanecarboxylic Acids, insecticidal activity of cyclopentenolone esters of, **124, 125.** (See also under Chrysanthemum Carboxylic Acids.)

D

D034, **130.**
D220, **130.**
Dacrydium franklinii, essential oil from, as synergist for pyrethrum, **165.**
daghestanicus, Dermacentor.
Dairy Barns, measures against flies in, **145, 175, 179.**
Damalinia bovis, seasonal incidence of, on cattle in Wisconsin, **104** ; control of, by clipping, **104.**
damnosum, Simulium.
DANP (see Dianisyl Neopentane).
Danubiosimulium (see *Simulium*).
darlingi, Anopheles (*Nyssorhynchus*).
DDA [bis(p-chlorophenyl) acetic acid], DDT not metabolised to, in *Musca domestica*, **176.**
DDD, against mosquitos and mosquito larvae, **31, 80, 178, 204** ; toxicity of deposits of, to *Musca domestica*, **44, 150** ; experiment with *M. domestica* and vapour of, **44** ; toxicity of, to strains of *Pediculus h. humanus*, **106** ; aircraft application of, **204** ; use of heat-liquefied, **150** ; specifications for, **31** ; (and p,p'DDD), chemical definitions of, **2.**
DDE (1,1-bis(p-chlorophenyl)-2,2-dichloroethylene), metabolism of DDT to, in strains of *Musca domestica*, **123, 176, 177.**
DDT, against *Glossina*, **211, 212** ; against adults and larvae of blowflies, **65, 83, 172, 196** ; against *Musca domestica*, **44, 53, 54, 60, 70, 71, 74, 75, 76, 126, 132, 137, 150, 151, 156, 175, 204, 206, 208** ; strains of *M. domestica* resistant to, **60, 69, 70, 71, 74, 75, 76, 81, 82, 121-124, 126, 132, 136, 137, 138, 140, 145, 156, 158, 159, 171, 174-177, 199, 204, 206, 209** ; susceptibility or resistance to, in larvae of *M. domestica*, **36, 136** ; absorption and metabolism of, in *M. domestica*, **123, 176, 177, 208, 209** ; differences in forms and mechanisms of resistance of *M. domestica* to, **122, 123, 159, 176** ; factors affecting assessment of resistance of *M. domestica*

to, **122, 176** ; technique for topical treatment of *M. domestica* with, **122, 208** ; question of resistance to, in *M. nebulo*, **94, 95, 124** ; effect of inbreeding and sex on susceptibility of *Drosophila* to, **140, 141** ; resistance to, in strains of *Drosophila*, **158** ; against mosquitos, **10-12, 23, 24, 30, 31, 41, 42, 53, 54, 57, 58, 60, 76, 80, 88, 89, 92, 128, 131, 143, 152-155, 156, 172, 173, 178, 198, 205, 206** ; effect on mosquitos of using, against cotton pests, **144** ; effect of, on oviposition by *Aëdes sollicitans*, **105** ; against mosquito larvae, **12, 23, 30, 31, 43, 48, 54, 55, 56, 72, 73, 80, 103, 143, 144, 151, 152, 172, 173, 201, 204, 205** ; factors affecting laboratory tests of, against Anopheline larvae, **41, 73** ; ineffective against pupae of mosquitos, **144** ; problems of resistance to, in mosquitos or mosquito larvae, **48, 72, 73, 127, 152, 205** ; against *Culicoides*, **136** ; against Simuliid adults, **24, 41, 42, 202** ; against Simuliid larvae, **24** ; against *Melophagus ovinus*, **73** ; against larvae of *Dermatobia* and *Hypoderma*, **35, 110** ; against *Cimex lectularius*, **69, 156** ; against cockroaches, **76** ; strains of *Blattella germanica* resistant to, **104, 139, 179** ; study of inheritance of resistance to, in *B. germanica*, **104** ; against fleas, **87, 156, 157, 171, 172, 191, 192** ; experimentally acquired resistance to, in *Xenopsylla cheopis*, **157** ; metabolism of, by *Oncopeltus fasciatus*, **123** ; against *Pediculus humanus*, **106, 156, 157** ; strains of *P. humanus* resistant to, **106, 157, 159** ; dehydrochlorination not accounting for resistance of *P. humanus* to, **159** ; against louse and mites on fowls, **46, 47, 102** ; against *Latrodectus*, **65** ; against ticks, **77, 156, 195** ; testing of, on *Tribolium confusum*, **138** ; against Trichoptera, **52** ; against pests of rice, **43** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157, 178** ; mode and mechanism of action of, on insects, **49, 64, 122, 208, 209** ; effects of temperature on toxicity and absorption by insects of, **138, 140** ; question of repellent or activating action of, **11, 44, 128, 151, 152, 153, 154, 155** ; lack of fumigant action of vapours of, **44** ; solutions of, **10, 11, 12, 23, 30, 31, 36, 41, 44, 52, 54, 55, 56, 58, 71, 74, 75, 80, 103, 122, 151, 152, 156, 157, 172, 211, 212** ; emulsions of solutions of, **10, 11, 30, 31, 41, 43, 54, 60, 75, 80, 103, 110, 126, 150, 151, 191, 195, 204, 211** ; in wettable-powder suspensions, **10, 11, 16, 30, 31, 43, 44, 54, 77, 80, 124, 128, 138, 150, 151, 153, 155, 157, 191, 195, 206** ; other forms of suspensions of, **41, 48, 54, 153, 195, 205** ; comparison of formulations of, **11, 153** ; specifications for preparations of, **30, 31** ; use of heat-liquefied, **150, 151** ; in aerosols, **24, 31, 52, 54, 65, 70, 72, 73, 76, 82, 143, 151, 152, 172, 173, 196, 202, 204, 211, 212** ; fog generators applying, **31, 52, 143, 172, 173, 196** ; in dips, **73, 195** ; in dusts and powders, **30, 31, 46, 47, 65, 87, 102, 106, 144, 157, 171, 172, 173, 195** ; diluents for dusts of, **31, 171** ; in ointment, **35** ; in direct-contact and space sprays, **31, 126, 151** ; equipment for applying sprays of, **31** ; applied by continuous vaporisation, **75, 76** ; application of, from aircraft, **23, 30, 41, 42, 43, 54-56, 57, 72, 73, 103, 136, 151, 152, 172, 202, 204, 211, 212** ; toxicity of, on treated surfaces, **10-12, 44, 46, 52, 53, 54, 57, 60, 70, 75, 80, 81, 82, 88, 89, 92, 95, 126, 128, 131, 138, 150, 151, 152-155, 156, 157, 174, 175, 198, 206** ; effect of type of surface on toxicity of, **54, 151, 154, 157** ; other factors affecting toxicity of surface deposits of, **11, 44, 54, 138, 154** ; probable action of airborne particles from deposits of, **154** ; outdoor persistence of deposits of, **58** ; treatment of aircraft with, **150, 204** ; treatment of vehicles with, **172** ; duration of effectiveness of, in water, **54** ; carriage of, by silt in rivers, **24** ; burlap covers for treating water barrels with, **103** ; cattle not affected by treatment with, **195** ; in milk and fat of treated cattle, **16, 195** ; effects of, on fish, **54** ; radioactive tracer studies of, **140** ; and allethrin, **204** ; and BHC, **144, 153** ; and chlordane, **60** ; and Lethane 384, **204** ; and pyrethrum extract, **31, 106, 204** ; and Pyrolan, **70, 71** ; and resin, **150, 151** ; and sulphur, **73, 144** ; and thanite, **82** ; synergists for, **74, 75, 138, 175, 176, 206** ; effect of piperonyl cyclonene on cuticle penetration and toxicity of, **176** ; (and p,p′DDT), chemical definitions of, **2.**

DDT Analogues, and related compounds, toxicity of, to fleas, **87** ; experiments with mosquitos and, **155** ; as synergists for DDT and methoxy-DDT,

74, 75 ; relation of structure to synergistic action of, **74.** (See Bromo-DDT, DDD, Dianisyl Neopentane, Fluoro-DDT, Methoxy-DDT and Methyl-DDT.)
Deer-mice (see *Peromyscus*).
deliensis, *Trombicula*.
Dengue, and mosquitos in Guam, **102, 103.**
Denmark, insecticide-resistance in strains of *Musca domestica* in, **123.**
dentatus, *Phlebotomus*.
Dermacentor albipictus, hosts and relation to spotted fever of, in U.S.A., **18.**
Dermacentor andersoni, **18** ; in Canada, **45** ; paralysis caused by male of, in man, **45.**
Dermacentor daghestanicus, chaetotaxy of, **20.**
Dermacentor marginatus, on cattle and rodents in Siberia, **66, 67** ; effect of pasture improvement and ploughing on, **66, 67** ; chaetotaxy of, **20.**
Dermacentor occidentalis, in U.S.A., **18** ; *D. albipictus* identified as, **18.**
Dermacentor pictus, on cattle and rodents in Siberia, **66, 67** ; effect of pasture improvement and ploughing on, **66, 67.**
Dermacentor variabilis, **18** ; DDT spray against, in U.S.A., **77.**
Dermanyssus gallinae (in U.S.A.), attacking man, **109** ; in birds' nests, **109** ; treatments against, on fowls, **46, 47.**
Dermatitis, Trombiculids causing, **50** ; other mites causing, **8, 33** ; not caused by *Dermanyssus gallinae*, **109.**
Dermatobia hominis (on cattle), in Brazil, **35, 36, 96, 182, 197** ; in Nicaragua, **34, 109** ; bionomics of, **35** ; measures and experiments against, **34-36, 96, 109, 182, 197.**
Dermatophagoides scheremetewskyi, treatments and persistence of infestation of man by, **33.**
Derris, spray pressure not influencing effectiveness of, against *Hypoderma*, **45.**
DFDT (see Fluoro-DDT).
D.H.S. Activator (see Ethylene Glycol Ether of Pinene).
diabolicus, *Culicoides* (see *C. guttatus*).
Diabrotica undecimpunctata howardi, **107.**
Diamanus montanus, on *Citellus beecheyi* in U.S.A., **64, 150** ; experiments with plague and, **64, 85** ; blood digestion in, **85** ; effect on, of temperatures of host burrows, **150.**
1,1-Dianisyl Neopentane, resistance of strains of insects to, **159.**
Dianisyl Trichloroethane (see Methoxy-DDT).
Diarrhoeal Diseases, effect of fly control on incidence of, in Georgia, **126.** (See Intestinal Bacteria.)
Diatomite, as carrier for BHC, **130.**
Diazinon, uses and value of, as an insecticide, **179, 198, 199** ; composition and properties of, **179, 198** ; and methoxy-DDT, **179.**
1,1-Di(p-bromophenyl)-2,2,2-trichloroethane (see Bromo-DDT).
S-(1,2-Dicarbethoxyethyl) O,O-Dimethyl Dithiophosphate (see Malathon).
Dichlorodifluoromethane, as propellent for aerosols, **204.**
Di(p-chlorophenoxy)methane, uses of, against mite on fowls, **102.**
Di(p-chlorophenyl), compounds containing (see under Bis(p-chlorophenyl).
Dicophane (see DDT).
Dieldrin, against *Culicoides*, **136, 137** ; effect of inbreeding and sex on susceptibility of *Drosophila* to, **140, 141** ; toxicity of, to fleas, **87, 156, 157** ; against *Melophagus ovinus*, **139** ; against mosquitos, **31, 153, 154, 155, 156, 178** ; mosquitos not activated by, **154** ; toxicity of, to larvae and pupae of mosquitos, **144** ; ineffective against resistant larvae of *Culex tarsalis*, **48** ; against *Musca domestica*, **126, 137, 156, 171, 175** ; responses of *M. domestica* to vapours of, **44** ; resistance of strains of *M. domestica* to, **82, 122, 124, 126, 135, 136, 137, 159, 171, 174, 175, 199** ; effect of using, against larvae of *M. domestica*, **135, 136** ; toxicity of, to strains of *Pediculus h. humanus*, **106, 156, 157, 159** ; against ticks, **47, 156, 180, 181** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157, 178** ; in solutions, **137** ; in emulsified solutions, **16, 126, 136, 180** ; specifications for emulsion concentrates of, **31** ; in wettable-powder suspensions, **136, 153, 155, 171** ; in aerosols, **137** ; in dusts, **87, 139** ; in pellets, **136** ; in sprays, **16, 47, 137, 171, 180, 181** ; applied from aircraft, **136** ; strips of material treated with, **175** ; deposits of, **47, 82, 126, 137, 153, 154, 155, 171, 174, 175** ; possible action of airborne particles from deposits of, **153, 154** ; in milk of sprayed cows, **16** ; investigations on risks of using, **186, 187** ; chemical definitions of, **2, 144** (note).
Diesel Oil, DDT applied from aircraft in, against mosquito larvae, **103.**

Diethyl Ether, strain of *Drosophila* resistant to, **158.**
Diethyl 2-(Ethylmercapto)ethyl Thiophosphate, proportions of isomers of, in Systox, **174.**
O,O-Diethyl O-(2-Isopropyl-4-methylpyrimidyl(6)) Thiophosphate (see Diazinon).
Diethyl 3-Methyl-pyrazolyl(5) Phosphate (see Pyrazoxon).
O,O-Diethyl O-(3-Methyl-pyrazolyl(5)) Thiophosphate (see Pyrazothion).
Diethyl p-Nitrophenyl Phosphate (see Paraoxon).
O,O-Diethyl O-p-Nitrophenyl Thiophosphate (see Parathion).
O,S-Diethyl O-p-Nitrophenyl Thiophosphate, insecticidal and anti-cholinesterase activity of, **173** ; isomerisation of parathion to, **173, 174.**
1,1-Di(p-fluorophenyl)-2,2,2-trichloroethane (see Fluoro-DDT).
Dihydrochrysanthemum Monocarboxylic Acid (see 2-Isobutyl-3,3-dimethylcyclopropanecarboxylic Acid).
O,O-Diisopropyl O-p-Nitrophenyl Thionophosphate (see Isopropyl-parathion).
Dilan (or CS-708) [mixture of 1,1-bis(p-chlorophenyl)-2-nitrobutane and -2-nitropropane], spray deposits of, against *Musca domestica*, **171, 175** ; strains of *M. domestica* resistant to, **175** ; ineffective in wash against *Hypoderma*, **102** ; in milk of sprayed cows, **16.**
1,1-Di(p-methoxyphenyl)-2,2,2-trichloroethane (see Methoxy-DDT).
1,1-Di(p-methoxyphenyl)-2,2,2-trimethylethane (see Dianisyl Neopentane).
3,4-Dimethylbenzoic Acid, morpholide of, in repellent mixture against Simuliids, **201.**
Dimethyl Carbate, alone and in mixture as repellent against mosquitos, **72, 203** ; treatments of clothing with, **203** ; chemical definition of, **2.**
O,O-Dimethyl S-(1,2-dicarbethoxyethyl) Dithiophosphate (see Malathon).
2,2-Dimethyl-3-nitro-cyclopropanecarboxylic Acid, allethrolone ester of, **125.**
O,O-Dimethyl O-p-Nitrophenyl Thiophosphate (see Methyl-parathion).
1,1-Di(p-methylphenyl)-2,2,2-trichloroethane (see Methyl-DDT).
Dimethyl Phthalate (as repellent), against *Culicoides*, **86** ; against mosquitos, **72, 202, 203** ; against Simuliids, **39, 147, 201** ; ineffective against *Stomoxys calcitrans*, **34** ; against Tabanids, **160** ; treatment of clothing with, **203** ; in mixtures with other repellents, **72, 201, 202.**
dimidiata, Chrysops.
Dimite (see Bis(p-chlorophenyl) Methyl Carbinol).
Dinex, chemical definition of, **2** ; method of citing salts and esters of, **2.**
Dinitro-o-sec.-amylphenol (see Dinosam).
2,4-Dinitroanisole, in powders against *Pediculus h. humanus*, **106.**
Dinitro-o-sec.-butylphenol (see Dinoseb).
Dinitro-o-cresol (see DNC).
Dinitro-o-cyclohexylphenol (see Dinex).
2,4-Dinitro-6-methylphenol (see DNC).
Dinosam, chemical definition of, **2** ; method of citing salts and esters of, **2.**
Dinoseb, chemical definition of, **3** ; method of citing salts and esters of, **3.**
Dipetalonema streptocerca, investigations on vector of, in Belgian Congo, **98, 99.**
dipodilli, Spirochaeta.
Dipodillus, new spirochaete of, transmitted by *Ornithodoros erraticus* in Kenya, **8, 9.**
Dips, against cattle ticks, **16, 195** ; physico-chemical studies of factors affecting application of, to sheep fleece, **129** ; BHC in, **195** ; DDT in, **195** ; sodium arsenite in, **16** ; planning and use of installations for, **149.**
Ditolyl Trichloroethane (see Methyl-DDT).
Ditreen, **153.**
Dixanthogen, preparations containing, against mange mites and lice on domestic animals, **111.**
DMC (see Bis(p-Chlorophenyl) Methyl Carbinol).
DNC, chemical definition of, **3** ; method of citing salts and esters of, **3.**
Dog Biscuit, as medium for rearing fly larvae, **109, 145** ; as food for mosquito larvae, **107.**
Dogs, encephalitis virus in, in China, **128** ; attractiveness of, for mosquitos, **162, 163.**
domestica, Musca.
domesticus, Anopheles (*Nyssorhynchus*) *albitarsis.*
Donkeys, *Gasterophilus pecorum* infesting, **183** ; attracting *Anopheles pseudopunctipennis*, **89.**
dorsalis, Aëdes ; Chironomus.
Doryphora sassafras, essential oil from, as synergist for pyrethrum, **165, 166.**
Drainage, against Anopheline larvae, **190, 191.**
dromedarii, Hyalomma.

Droplet Sizes, of aerosols and sprays dispersed from aircraft, **54, 55, 151, 152, 212** ; definitions of, **55, 151.**
Drosophila, cytological basis of inheritance in, **119, 120.**
Drosophila melanogaster, methods of using for insecticide tests, **37, 38** ; effect of inbreeding and sex on susceptibility to insecticides of, **140, 141** ; studies of insecticide resistance in strains of, **37, 38, 157, 158** ; cold-resistant strain of, **158.**
Dung, effects of type of, on development of *Musca domestica*, **199, 200** ; treatment of, with insecticides against flies, **135.**
dureni, Anopheles.
Dusts, equipment for applying, **31, 149** ; equipment for simultaneous application of sprays and, from helicopters, **141** ; sprays compared with, against *Dermatobia hominis*, **182.**
duttoni, Spirochaeta (*Borrelia*).
dysenteriae, Shigella.
Dysentry, carriage of bacilli of, by *Calliphora uralensis*, **83.** (See Intestinal Bacteria.)

E

E-600 (see Paraoxon).
E-605 (see Parathion).
E-605 f, **149.**
East Coast Fever (see *Theileria parva*).
echidninus, Echinolaelaps.
Echidnophaga gallinacea, on rodents in U.S.A., **31, 32, 133, 171, 172** ; of no importance as vector of plague or murine typhus, **133** ; not controlled by dusting with DDT, **172.**
Echinolaelaps echidninus, on rats in U.S.A., **32.**
Economic Entomology, book on, **197.**
Ecuador, *Anopheles pseudopunctipennis* and malaria in, **90** ; other mosquitos and yellow fever in, **170, 171** ; eradication of *Aëdes aegypti* from coastal, **170.**
Egypt, forms of *Culex pipiens* in, **119, 206, 207** ; doubtful occurrence of *Ornithodoros erraticus* in, **193** ; *Pediculus humanus humanus* in, **157** ; resistance to DDT in *P. h. humanus* in, **157, 159, 160** ; *Pulex irritans* in, **157.**
Elemicin, as synergist for pyrethrum, **165.**
Elk, tick on, in U.S.A., **18.**
Ellice Islands, new mosquito recorded as *Aëdes pseudoscutellaris* in, **161.**
Elodea canadensis, larvae of *Anopheles quadrimaculatus* associated with, **49.**
elutus, Anopheles maculipennis (see *A. m. sacharovi*).
Encephalitis, Chinese Aestivo-autumnal, relation of mosquitos to, in Peking, **127, 128** ; domestic animals probably infected with, **128** ; probably identical with Japanese B encephalitis, **127.**
Encephalitis, Japanese B, in Guam, **189** ; in Okinawa, **188** ; virus probably identical with, in China, **129** ; mosquitos associated with, **188, 189** ; experiments with mosquitos and, **31, 58, 127, 186, 189, 190** ; probably in domestic animals, **128.**
Encephalitis, St. Louis, relation of *Culex tarsalis* to, in California, **127.**
Encephalitis, Western Equine, relation of *Culex* spp. to, in Canada and U.S.A., **65, 66, 127, 209** ; in horses, **66** ; in man, **127.**
Encephalomyelitis, Equine (see Encephalitis).
Endrin, experiment with mosquitos and deposits of, **154** ; toxicity of, to larvae and pupae of mosquitos, **144** ; chemical definition of, **144** (note).
Entomological Techniques, manual of, **213.**
Enzymes, of blowfly larvae, relation of, to infestation of sheep, **68.** (See also Cholinesterases and Lipase.)
Eomenacanthus (see *Menacanthus*).
Ephestia kuehniella, experiments with Pyrolan and, **69.**
EPN (see Ethyl p-Nitrophenyl Thionobenzenephosphonate).
equi, Chorioptes ; Psoroptes ; Sarcoptes (see *S. caballi*).
equinum, Simulium (*Eusimulium*).
equinus, Haemagogus.
Eremophila mitchelli, essential oil from, as synergist for pyrethrum, **165.**
Eretmapodites silvestris conchobius, habits and possible relation to yellow fever of, in Sudan, **190.**
erraticus, Ornithodoros.
Erythrina, association of *Anopheles bellator* with, in Trinidad, **16.**
erythrocephala, Calliphora.
Escherichia coli, experiments with *Musca domestica* and, **188.**
Ethiopian Region, species of *Aëdes* (*Stegomyia*) in, **146** ; *Phlebotomus* of, **17.**
2-Ethyl-1,3-hexanediol (as repellent), against mosquitos, **72, 202, 203** ; against Simuliids, **201** ; ineffective against *Stomoxys calcitrans*, **34** ; in mixtures with other repellents, **72, 201, 202.**

N-(2-Ethylhexyl)bicyclo[2.2.1]-5-heptene -2,3-dicarboximide, as synergist for allethrin, **204** ; as synergist for pyrethrum, **164, 204** ; stoichiometric relations of, with pyrethrins, **164.**
Ethyl p-Nitrophenyl Thionobenzenephosphonate, effectiveness and methods of applying, against mosquito larvae, **167** ; effect of isomerisation on insecticidal and anti-cholinesterase activity of, **173, 174.**
Ethyl β-Phenylhydracrylate, treatments of clothing with, as repellent against mosquitos, **203.**
Ethylene Glycol Ether of Pinene, ineffective as synergist for pyrethrum, **164.**
Ethylene Glycol Monoethyl Ether, in concentrate for producing DDT suspension, **54.**
Eucalliphora (see *Calliphora*).
Eudesmin, **166.**
eurysternus, Haematopinus.
Eurytoma arachnovora, parasitising eggsacs of *Latrodectus geometricus* in Philippines, **65.**
Euschöngastia indica, Rickettsia orientalis in, on tree squirrels in Malaya, **31.**
Eusimilium equinum (see *Simulium*).
evanescens, Trichogramma.
evansi, Trypanosoma.
Evodia littoralis, evodionol isolated from, **165.**
Evodionol, as synergist for pyrethrum, **165.**
excavatum, Hyalomma anatolicum.
Eye Gnats (see *Hippelates*).

F

Faeces, rate of development of *Musca domestica* in, **199, 200.**
faini, Simulium.
Fairy Shrimps, DDT against, in ricefields in California, **43.**
falciparum, Plasmodium.
falco, Haemagogus spegazzinii.
fallax, Anopheles maculipennis.
farauti, Anopheles.
fasciatus, Nosopsyllus ; Oncopeltus.
fatigans, Culex pipiens.
felis, Ctenocephalides.
Fiji, mosquitos in, **161.**
Filaria bancrofti (see *Wuchereria*).
Filaria loa (see *Loa*).
Filaria ozzardi (see *Mansonella*).
Filaria perstans (see *Acanthocheilonema*).
filariferus, Culicoides (see *C.guttatus*).
Finlaya (see *Aëdes*).
Fish, use of, against Anopheline larvae, **93, 146, 190** ; effects of mosquito larvicides on, **54** ; killed by vaporised lindane, **109.**
Flame-throwers, **149.**
flavipes, Hippelates.
flavirostris, Anopheles minimus.
Fleas, possible relation of, to filariae, **99** ; and plague, **64, 132, 133, 171, 191, 192** ; studies related to plague infection in, **85** ; experiments with *Rickettsia burneti* and, **192** ; and typhus, **32** ; survival and infectivity of typhus rickettsiae in faeces of, **132** ; on rats, **31, 32, 64, 132, 133, 191, 192** ; comparison of mice and rats as hosts for, **66** ; on other rodents, **64, 150, 171, 172** ; effect of microclimate of rodent burrows on, **150** ; on domestic animals, **110** ; key to species of, on livestock in Australia, **112** ; carriage of, in aircraft, **200**; measures and experiments against, **87, 110, 156, 157, 171, 172, 191, 203** ; experimentally acquired resistance to DDT in, **157** ; not affected by warfarin, **32.**
Flowers, uptake of radioactive phosphorus from, by mosquitos, **23.**
fluminensis, Anopheles.
Fluoro-DDT, against Anophelines, **146** ; irritation of Anophelines by, **155** ; against *Cimex lectularius*, **13** ; experiments with *Musca domestica* and, **44, 82, 150** ; reactions of strains of *M. domestica* to, **82** ; strain of *Drosophila* resistant to, **158** ; deposits of, **13, 82, 146, 150, 155** ; vapours of, **44** ; use of heat-liquefied, **150** ; (and p,p′fluoro-DDT), chemical defininitions of, **3.**
Fly-grills, for measuring populations of flies, **126.**
Fly-sprays (see Atomised Sprays).
Fog Generators, insecticides applied by, **31, 52, 143, 172, 173.**
Fonsecaonyssus (*Leiognathus*) *sylviarum*, acaricides against, on fowls in U.S.A., **102** ; infesting man, **34.**
Formosa, Anophelines of, **49, 57.**
Formula 6-2-2 (dimethyl phthalate, Indalone and 2-ethyl-1, 3-hexanediol), as repellent : against mosquitos, **72, 202, 203** ; against Simuliids, **201.**
Fowl Mite, Northern (see *Fonsecaonyssus sylviarum*).
Fowls, lice on, **46, 110** ; mites on, **46, 50, 102, 194** ; *Argas persicus* on, **46** ; relations of *Ornithodoros moubata* to, **130** ; *O. moubata* experimentally transmitting spirochaete of, **169** ; experiments with *Plasmodium gallinaceum* in, **169, 170.**

France, mosquitos in, **119, 120** ; *Culicoides* and *Onchocerca* of horses in, **100.**
freeborni, *Anopheles maculipennis*,
freetownensis, *Phlebotomus.*
Freon 12 (see Dichlorodifluoromethane).
funestus, *Anopheles.*
Fungi, infesting eggs of *Rhipicephalus sanguineus*, **81** ; rearing of Trombiculids affected by, **4, 7.**
furens, *Culicoides.*
Furethrin, tests of, against *Musca domestica*, **47, 74** ; preparation of, **47.**
Furethrolone, preparation and use of, for synthesis of furethrin, **47** ; insecticidal activity of ester of natural chrysanthemum monocarboxylic acid and, **74.**
2-(2-Furfuryl)-4-hydroxy-3-methyl-2-cyclopenten-1-one (see Furethrolone).
2-Furoic Acid, allethrolone ester of, **125.**
Fusarium, infesting eggs of *Rhipicephalus sanguineus*, **81.**

G

G-382, **204.**
gallinacea, *Echidnophaga.*
gallinaceum, *Plasmodium.*
gallinae, *Dermanyssus.*
gallinarum, *Spirochaeta* (*Borrelia*) (see *S. anserina*).
Gambia, forms of *Anopheles gambiae* in, **116.**
gambiae, *Anopheles.*
gambiense, *Trypanosoma.*
Gambusia, use of, against Anopheline larvae in Italy, **146.**
Gambusia patruelis, use of, against Anopheline larvae in Montenegro, **93.**
gamma, *Autographa* (*Plusia*).
Gammexane P.520, **11.**
Gasterophilus, key to species of, in Australia, **112.**
Gasterophilus pecorum, bionomics of, in Kazakhstan, **183.**
gelidus, *Culex.*
Gentian Violet, against *Dermatophagoides*, **33.**
geometricus, *Latrodectus.*
Gerbils (see *Dipodillus* and *Rhombomys*).
germanica, *Blattella* (*Phyllodromia*).
Germany, *Cimex lectularius* in, **13, 68, 149** ; mosquito in, **120** ; *Hypoderma* in cattle in, **23.**
gibsoni, *Culicoides.*
Gix (see Fluoro-DDT).
Glossina, in Liberia, **53** ; humidifier used in rearing of, **156.**
Glossina morsitans, in Tanganyika, **27, 39** ; transmission of hybrid trypanosomes by, **26, 27** ; rate of blood digestion in, **210** ; seasonal factors affecting size of, **39.**
Glossina palpalis, transmitting *Trypanosoma gambiense* in Liberia, **53** ; aircraft applications of insecticides against, in Uganda, **211, 212.**
Glossina pallidipes, in Tanganyika, **39** ; seasonal factors affecting size of, **39, 40.**
Glossina swynnertoni, in Tanganyika, **39, 212** ; rate of blood digestion in, **210** ; seasonal factors affecting size of, **39, 40** ; aircraft application of DDT against, **212.**
Glycol, pinene ether of, as repellent against *Stomoxys calcitrans*, **34.** (See also Ethylene Glycol.)
Goats, attractiveness of, for mosquitos, **89, 94, 162, 163** ; tick on, **16.**
Gold Coast, Simuliids and *Onchocerca volvulus* in, **29, 147.**
gomezi, *Phlebotomus.*
grabhami, *Anopheles.*
grahami, *Culicoides.*
granaria, *Calandra.*
Gravisia aquilega, and *Anopheles bellator* in Trinidad, **16.**
griseicolle, *Simulium.*
Grivet Monkey (see *Cercopithecus aethiops centralis*).
Ground Squirrels (see *Citellus*).
Guam, mosquitos in, **102, 103, 189, 190;** dengue in, **102, 103** ; Japanese B encephalitis in, **189** ; risk of introduction of *Wuchereria bancrofti* into, **189.**
guamensis, *Aëdes.*
guarao, *Anopheles.*
Guatemala, *Anopheles* spp. in, **80** ; *Culicoides* spp. in, **85, 86** ; *Phlebotomus* in, **63** ; Simuliids and *Onchocerca volvulus* in, **15** ; possible relation of *Culicoides* to *O. volvulus* in, **86.**
Guiana, French, *Phlebotomus* in, **63.**
Guineapigs, used in tests of treatments against *Dermatobia hominis*, **35, 36.**
guttatus, *Culicoides.*
gwyni, *Polygenis* (*Rhopalopsyllus*).

H

hackeri, *Anopheles leucosphyrus.*
Haemagogus, and yellow fever in Brazil, **59.**
Haemagogus argyromeris, attacking man in Panama, **26** ; bionomics of, in Panama, **79.**
Haemagogus chalcospilans, bionomics of, in Panama, **26, 79.**

Haemagogus equinus, in Panama, **26, 79** ; yellow fever associated with, **26** ; bionomics of, **79.**
Haemagogus lucifer, in Panama, **26, 79** ; yellow fever associated with, **26** ; bionomics of, **79.**
Haemagogus spegazzinii falco, in Ecuador, **170, 171** ; in Panama, **26, 79** ; and yellow fever, **26, 170, 171** ; bionomics of, **79, 170.**
Haemaphysalis bispinosa, on cattle in U.S.S.R., **83** ; parthenogenesis of, **83.**
Haematopinus eurysternus, on cattle in Australia, **180.**
Haematopinus quadripertusus (on cattle), distribution of, **180.**
Haematopinus suis, on pigs in U.S.S.R., **110** ; tests and use of SK-9 against, **110.**
Haematopinus tuberculatus, on cattle in Australia, **180.**
Haemolaelaps mohrae, bionomics and relation to tularaemia of, on rodents in U.S.S.R., **184, 185.**
hancocki, *Anopheles.*
Hares, tick on, **19.**
harveyi, *Spirochaeta.*
hasseltii, *Latrodectus.*
Hawaii, introduction of *Toxorhynchites brevipalpis* into, against other mosquitos, **77, 78.**
Heat, reactions to, of immature stages of related mosquitos, **145.**
HCH (see BHC).
hectoris, *Anopheles.*
Helicopters, sprays applied from, against mosquitos, **57** ; deposition of atomised sprays from, **55** ; types of, for applying insecticides, **149** ; equipment for applying insecticides from, **141.**
Heliopsis, scabrin (*q.v.*) a constituent of, **125.**
hemipterus, *Cimex.*
Hendecenoic Acid (see Undecylenic Acid).
Heptachlor, resistance to, in larvae of *Culex tarsalis*, **48** ; against *Culicoides*, **136** ; toxicity of, to fleas, **87** ; experiments with *Musca domestica* and, **44, 82, 121, 150** ; resistance of strains of *M. domestica* to, **82, 121, 135** ; effect of using, against larvae of *M. domestica*, **135** ; dust containing, **87** ; in emulsified solution, **136** ; in acetone-water suspension, **48** ; deposits of, **82, 121, 150** ; vapours of, **44** ; use of heat-liquefied, **150** ; chemical definition of, **3.**
Heptachlorodicyclopentadiene (see Heptachlor).
Heptachlorotetrahydroendomethyleneindene [or methanoindene] (see Heptachlor).
hermsi, *Ornithodoros* ; *Spirochaeta* (*Borrelia*).
Heron (see *Ardea cinerea*).
1,2,3,4,5,6-Hexachlorocyclohexane (see BHC).
1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-endo-dimethanonaphthalene (see Endrin).
1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-exo-dimethanonaphthalene (see Dieldrin).
1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-endo-endo-dimethanonaphthalene (see Isodrin).
1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-endo-exo-dimethanonaphthalene (see Aldrin).
hexodontus, *Aëdes.*
hilli, *Anopheles amictus.*
Hippelates, bionomics, identity and relation to conjunctivitis of species of, in U.S.A., **40, 87, 88.**
Hippelates bishoppi, confused with *H. pusio* in U.S.A., **40, 87** ; ecology of, **40.**
Hippelates collusor, recorded as *H. pusio* in Coachella Valley (California), **87** ; status of, **87.**
Hippelates flavipes, **87.**
Hippelates pusio, in U.S.A., **40, 87** ; related species recorded as, **40, 87.**
hirsutum, *Simulium.*
hispanica, *Spirochaeta* (*Borrelia*).
hispaniola, *Anopheles.*
holmbergi, *Anopheles* (see *A. fluminensis*).
hominis, *Dermatobia.*
Honduras, *Anopheles crucians* in, **80.**
Honduras, British, *Anopheles crucians* in, **80.**
Hong Kong, Anophelines and their relation to disease in, **94.**
Hoplopsyllus anomalus, on *Citellus beecheyi* in California, **150** ; effect on, of temperature of host burrows, **150.**
Horses, *Gasterophilus pecorum* infesting, **183** ; Simuliids attacking, **15** ; ticks on, **16, 18** ; *Culicoides* and *Onchocerca* in, **100** ; encephalitis viruses in, **66, 127, 128** ; rate of development of *Musca domestica* in dung of, **199, 200.**
House-fly (see *Musca domestica*).
Houses, habits of Anophelines in relation to, **57, 88, 114, 115, 117, 162** ; *Culex tarsalis* feeding in, **127** ; treatment of, with chlorinated-hydrocarbon insecticides against Anophelines, **10-12, 57, 60, 80, 88, 89, 92, 128, 131, 146,**

152-154, 206 ; effect of chlorinated hydrocarbons on *Culex pipiens fatigans* in, **153** ; parathion against *Cimex lectularius* in, **149** ; BHC against *Ornithodoros moubata* in, **130** ; insecticide treatments of, against *Pulex irritans*, **157** ; treatment of, with DDT against rat fleas, **191, 192** ; toxicity of DDT deposits on materials composing, **54.**

howardi, Diabrotica undecimpunctata.

Howler Monkeys (see *Alouatta*).

humanus, Pediculus.

Humidity, effects of : on *Chrysops silacea*, **27** ; on *Glossina*, **39, 40** ; on mosquitos, **84, 114, 115** ; on *Simulium venustum*, **210** ; on Trombiculids, **5, 6, 7** ; reactions of larvae of *Musca domestica* to, **199** ; hygrometer for microclimatic measurements of, **155** ; control of, in chamber for maintaining *Bdellonyssus bacoti*, **51** ; apparatus maintaining, in insect breeding rooms, **155.**

Huts (see Houses).

Hyalomma, experiments on parthenogenesis in species of, **67.**

Hyalomma anatolicum excavatum, parthenogenesis in, **67.**

Hyalomma dromedarii, **67.**

Hyalomma marginatum marginatum, **67** ; rickettsial disease transmitted by, in Crimea, **18, 19, 51** ; hosts of, **19.**

Hyalomma marginatum turanicum, **67.**

Hyalomma savignyi, duration of adult life of, **22.**

Hydrogen Cyanide, resistance to, in strains of *Drosophila*, **158.**

Hydrogen Sulphide, blowflies probably attracted by, **143.**

Hydrogen-ion Concentration, of breeding places of Egyptian *Culex pipiens*, **207.**

Hydropsyche, DDT aerosol against, in Ontario, **52.**

Hydrous triangularis, DDT against, in rice-fields in California, **43.**

2-Hydroxy-decachloro-4,7-methano-indan-1-one, as synergist with lindane against *Musca domestica*, **138, 175.**

Hygrometer, type of, for microclimatic work, **155.**

Hypoderma (in cattle), in U.S.S.R., **110** ; BHC reducing infestation by, **23** ; insecticide treatments against larvae of, **45, 101, 110.**

Hypoderma bovis (in cattle), in Germany, **23** ; in U.S.A., **101.**

Hypoderma lineatum, in cattle in Germany and Texas, **23, 45** ; in yak in Pamirs, **82.**

hyrcanus, Anopheles.

I

Immortelle Trees (see *Erythrina*).

implexus, Anopheles.

impukane, Simulium.

inamollae, Culicoides.

Indalone, as repellent: against mosquitos, **202, 203** ; against Simuliids, **201** ; against *Stomoxys calcitrans*, **34** ; treatment of clothing with, **203** ; formula 6-2-2 (*q.v.*) containing, **72, 201, 202.**

indefinitus, Anopheles subpictus.

India, Anophelines and malaria in, **10-12, 57, 58** ; *Phlebotomus argentipes* and visceral leishmaniasis in, **128** ; rats, fleas and plague in, **191** ; tick-borne relapsing fever in, **50** ; Trombiculids and tsutsugamushi disease in, **4, 5, 6, 7** ; other typhus-group fevers in, **5** ; *Musca nebulo* in, **94.**

indica, Euschöngastia.

indiensis, Anopheles hyrcanus.

Indo-China, *Anopheles leucosphyrus* and malaria in, **57, 58** ; anti-malaria legislation in, **190.**

Indonesia, Anophelines in, **57, 58** ; malaria in, **58.**

infestans, Triatoma.

Insect Cuticle, penetration of, by insecticides, **61, 64, 122, 155, 208.**

Insecticides, tests of organic compounds as potential, **124, 125** ; relation of chemical constitution to toxicity of, **74, 125, 155, 173** ; mode and mechanism of action of, **49, 61, 64, 122, 173, 208, 209** ; methods and apparatus for laboratory tests of, **135, 138, 141, 156, 198** ; bioassay of, **13, 48, 62, 70, 108** ; analysis of chlorinated organic, by partition chromatography, **112** ; book on, **148** ; surveys of data on, **113, 197** ; reviews of data on risks associated with, **77, 112, 213** ; book on equipment for applying, **149** ; standardisation of names for, **1-3.**

Insects, operations for control of, by U.S. Army in Far East, **172** ; determination of rate of increase of populations of, **168** ; book on physiology of, **148** ; book on techniques relating to studies of, **12** ; mode and mechanism of action of insecticides on, **49, 61, 64, 122, 208, 209.**

insignis, Culicoides (see *C. guttatus*).

Intestinal Bacteria, relation of flies to, **83, 126, 187.**

Iodo-DDT, mosquitos not irritated by deposits of, **155.**

Iraq, sandflies of, **40** ; dermal leishmaniasis in, **40.**

irritans, Pulex.

Isobornyl Thiocyanoacetate (see Thanite).
2-Isobutyl-3,3-dimethyl-cyclopropane-carboxylic Acid, toxicity of allethrolone ester of, to *Musca domestica*, **125.**
N-Isobutyloctadecapentaenamide (see Scabrin).
N-Isobutylundecylenamide, as synergist for pyrethrum, **164, 166** ; stoichiometric relations of, with pyrethrins, **164.**
Isodrin, experiment with mosquitos and deposits of, **154** ; toxicity of, to larvae and pupae of mosquitos, **144** ; chemical definition of, **144** (note).
p-Isopropoxybenzaldehyde, as repellent against Anophelines, **202.**
Isopropyl Alcohol, repellent mixture containing, **201.**
Isopropyl-parathion, effect of isomerisation on insecticidal and anticholinesterase activity of, **173, 174.**
Isosafrole, n-octyl sulphoxide of, as synergist with allethrin or pyrethrins, **101** ; n-propyl isome a condensation product of n-propyl maleate and, **164.**
2-Isovaleryl-1,3-indandione, as synergist for pyrethrum, **166.**
Italy, Anophelines in, **30, 60, 146, 205** ; malaria in, **60, 146** ; insecticide-resistance in strains of *Musca domestica* in, **60, 81, 122, 158.** (See also Sardinia.)
Ixodes, on domestic animals, etc., in Sakhalin, **83.**
Ixodes pacificus, **18.**

J

Jamaica, mite on thrush in, **195.**
jamaicensis, Cnemidocoptes.
Japan, work of U.S. Army on insect control in, **172, 173** ; hosts of *Trombicula akamushi* in, **194.**
japignyi, Phlebotomus.
Jeeps, EPN applied from, against mosquito larvae, **167.**
jeyporiensis, Anopheles.

K

K3, **111.**
K Soap, **111.**
Kaolin, as carrier for BHC, **130.**
karwari, Anopheles.
Keg Shelters, for *Anopheles quadrimaculatus*, **56** ; *A. albimanus* not found in, **91.**
Kensil F, **130.**
Kenya Colony, mosquitos in, **153** ; *Simulium neavei* in, **63, 111** ; lice on man in, **97** ; *Ornithodoros* spp. in, **8, 9, 97, 98, 130, 193** ; forms of relapsing fever in, **97, 98, 130** ; new spirochaetes in, **9, 97.**
Kerosene, as carrier for insecticide sprays, **10, 74, 82, 101, 107, 124, 125, 135, 142** ; method of applying sprays containing, from helicopters, **141** ; as solvent for applying insecticide deposits, **44, 54, 58, 71** ; *Musca domestica* repelled by, **44.**
Kerteszia (see *Anopheles*).
KIK Geigy, **201.**
kochi, Anopheles.
Korea, DDT-resistant strains of *Pediculus humanus* in, **106, 159, 160.**
kuehniella, Ephestia.

L

labranchiae, Anopheles maculipennis.
Laelaps muris (*agilis*), bionomics and relation to tularaemia of, on *Arvicola terrestris* in U.S.S.R., **185.**
Laelaps nuttalli, on rats in U.S.A., **32.**
lahorensis, Ornithodoros.
laneanus, Anopheles cruzii.
langi, Chrysops.
latipes, Simulium.
Latrodectus geometricus, natural enemies and control of, in Philippines, **65** ; toxicity of venom of, **65.**
Latrodectus hasseltii, **65.**
Latrodectus mactans, **65.**
Lead Arsenate, ineffective against *Culicoides*, **136.**
Leather, not effectively treated with melted DDT, **151.**
lectularius, Cimex.
Legislation, against malaria in Indo-China and Madagascar, **190.**
Leiognathus sylviarum (see *Fonsecaonyssus*).
Leishmania tropica, probably transmitted by *Phlebotomus sergenti* in Iraq, **40** ; in U.S.S.R., **184** ; correlation of development of, with gonotrophic cycle in *Phlebotomus*, **184.**
Leishmaniasis, Dermal (see *Leishmania tropica*).
Leishmaniasis, Visceral, in India, **128** ; and *Phlebotomus argentipes*, **128.**
Lemna minor, mosquito larvae associated with, **49.**
Leptopsylla segnis, on rats in U.S.A., **31, 32, 132, 133** ; of no importance as vector of plague or murine typhus,

133 ; experiments with *Rickettsia burneti* and, **192.**
Leptospermone, as synergist for pyrethrum, **166.**
Leptospermum scoparium, leptospermone found in oil of, **166.**
lesteri, *Anopheles hyrcanus.*
Lethane 384, **204.**
letifer, *Anopheles.*
leucocelaenus, *Aëdes* (*Finlaya*).
leucosphyrus, *Anopheles.*
leucotaeniatus, *Aëdes.*
Liberia, *Glossina* spp. and sleeping sickness in, **53** ; mosquitos and malaria in, **53** ; environmental conditions affecting insects and diseases in, **52.**
Lice, on domestic animals, **104, 110, 111, 196** ; on fowls, **46, 47, 110** ; on pigeons, **108** ; key to species of, on livestock in Australia, **112** ; clipping for control of, on cattle, **104** ; insecticides against, **46, 47, 110, 111** ; controlled by vaporised lindane, **108** ; on man (see *Pediculus* and *Phthirus*) ; on monkeys (see *Pedicinus*).
Light-traps, for *Culicoides*, **76.**
lilaea, *Calliphora* (*Eucalliphora*).
Lindane, definition of, **3.** (See BHC.)
lindesayi, *Anopheles.*
lineatum, *Hypoderma.*
Linognathus pedalis, bionomics of, on sheep in Australia, **196, 197.**
Linognathus vituli, on cattle in Australia, **180.**
Lipase, piperonyl butoxide possibly inhibiting inactivation of pyrethrins by, **61, 62.**
Liponyssus bacoti (see *Bdellonyssus*).
Litomosoides carinii (in *Sigmodon hispidus*), experiments with *Bdellonyssus bacoti* and, **7, 12, 33, 51.**
litoralis, *Culex.*
Loa loa, in British Cameroons, **27** ; in Belgian Congo, **98** ; in Nigeria, **28** ; in Sudan, **118** ; relation of Tabanids to, **27, 28, 118.**
longiceps, *Pedicinus.*
longicornis, *Chrysops.*
lophurae, *Plasmodium.*
Lucerne Meal, in medium for rearing *Musca domestica*, **81.**
lucifer, *Haemagogus.*
Lucilia cuprina (infesting sheep), in South Africa, **68** ; in Australia, **196** ; enzymes and nutrition of larvae of, **68** ; insecticides protecting sheep from, **196.**
Lucilia cuprina cuprina, method of marking, with radioactive phosphorus, **187.**
Lucilia pallescens (see *L. cuprina cuprina*).
Lucilia sericata, not infesting sheep in South Africa, **68** ; in U.S.A., **143** ; attracted by natural gas, **143.**
luteocephalus, *Aëdes.*
Lysol, against *Dermatophagoides*, **33.**

M

Macaca mulatta, used in experiment with yellow fever, **24.**
macellaria, *Callitroga.*
Macronema, DDT aerosol against, in Ontario, **52.**
mactans, *Latrodectus.*
maculatus, *Anopheles.*
maculipennis, *Anopheles.*
Madagascar, Anophelines of, **190** ; antimalaria legislation in, **190.**
Magnesium Sulphate, in water, effect of, on oviposition by mosquitos, **61.**
Malaria, in French West Africa, **115, 181** ; in Australia, **9, 10** ; in Borneo, **57, 58** ; in Brazil, **56, 57, 92, 116** ; in Burma, **57, 58** ; in Chile, **90, 96** ; in China, **49, 58, 113, 114, 117** ; in Ecuador, **90** ; in Hong Kong, **94** ; in India, **11, 57, 58** ; in Indo-China, **57, 58** ; legislation against, in Indo-China and Madagascar, **190** ; in Indonesia, **58** ; in Italy, **60, 146** ; in Liberia, **53** ; in Malaya, **58, 162** ; in Mexico, **80, 88, 128, 131, 132, 206** ; in Montenegro, **92, 93** ; in Okinawa, **188** ; in Peru, **89, 90** ; in Porto Rico, **91** ; absence of, in Sakhalin, **83** ; in U.S.A., **90** ; and mosquitos, **9, 11, 49, 53, 56, 57, 58, 60, 80, 88, 90, 91, 92, 93, 94, 96, 113, 114, 115, 116, 117, 128, 131, 146, 162, 181, 188, 189, 190, 191, 206** ; experiments with Anophelines and, **56, 89, 90, 131** ; factors affecting transmission of, by Anophelines, **90, 114, 115** ; report on terminology in, **116.** (See *Plasmodium* spp.)
Malaria, Avian (see *Plasmodium gallinaceum*, *P. lophurae* and *P. praecox*).
malariae, *Plasmodium.*
Malariol, **12.**
Malathon, toxicity of, to mosquitos, **178** ; test of, against mosquito larvae, **167** ; effect of isomerisation on insecticidal and antocholinesterase activity of, **173, 174** ; chemical definition of, **3.**
Malaya, Anophelines in, **58, 116-118, 162** ; other mosquitos in, **162, 163** ; malaria in, **58, 162** ; *Wuchereria malayi* in, **118** ; Trombiculids and tsutsugamushi disease in, **5, 6, 7, 31.**

malayi, *Wuchereria*.
Malignant Tertian Malaria (see *Plasmodium falciparum*).
Malt, in medium for rearing *Musca domestica*, **81.**
Man, mites infesting, **8, 33, 34, 109.** (See also Trombiculids.)
Mangareva Islands, new mosquito recorded as *Aëdes pseudoscutellaris* in, **162.**
Mange, in cattle and horses, **111** ; in sheep, **50, 110** ; treatments against, **110, 111.**
Mannitan Monolaurate, hydrolised by lipase, **62.**
Mansonella ozzardi, doubt on record of, in *Culicoides furens*, **99.**
Mansonia africana, in Belgian Congo, **99** ; in N. Rhodesia, **167** ; in Uganda, **94** ; experimental vector of yellow fever, **94** ; *Acanthocheilonema perstans* apparently not developing in, **99.**
Mansonia uniformis, in Belgian Congo, **99** ; feeding habits of, in Malaya, **163** ; in N. Rhodesia, **167** ; *Acanthocheilonema perstans* apparently not developing in, **99.**
Mansonioides (see *Mansonia*).
marginatum, *Hyalomma*.
marginatus, *Dermacentor*.
marianae, *Culex annulirostris*.
marlieri, *Simulium*.
Marquesas Islands, new mosquito recorded as *Aëdes pseudoscutellaris* in, **162.**
Marmosets (see *Callithrix*).
Marseilles Fever (see *Rickettsia rickettsi conori*).
Matairesinol, **166.**
Mauritius, new mosquito in, **146.**
Mayfly Nymphs, Simuliid pupae attached to, **63.**
Mealworm (see *Tenebrio molitor*).
Medical Entomology, books dealing with, **113, 197.**
Medical Zoology, index-catalogue of, **32.**
mediopunctatus, *Anopheles*.
megnini, *Otobius*.
Melaleuca bracteata, essential oil from, as synergist for pyrethrum, **165.**
melanogaster, *Drosophila*.
melas, *Anopheles gambiae*.
melleus, *Culicoides*.
Melolontha melolontha, **69.**
Melophagus ovinus, insecticide treatments against, on lambs in U.S.A., **73, 139** ; weight of lambs not affected by, **73, 139.**
Melopsittacus undulatus (see Budgerigar).
Menacanthus stramineus, insecticide treatments against, on fowls in U.S.A., **46, 47.**
Mercuric Iodide Soap, against *Dermatophagoides*, **33.**
merionesi, *Spirochaeta* (*Borrelia*) (see *S. crocidurae*).
Mermis, in *Simulium damnosum* in Sudan, **39.**
Mermithids, parasiting mosquito larvae, **60.**
messeae, *Anopheles maculipennis*.
metallicum, *Simulium*.
Meteorological Conditions, effects of, on activity of mosquitos and Simuliids, **23, 210.** (See Humidity and Temperature.)
p-Methoxyacetophenone, as repellent against *Stomoxys calcitrans*, **34.**
Methoxychlor (see Methoxy-DDT).
Methoxy-DDT, against mosquitos, **31, 178** ; against *Musca domestica*, **44, 75, 121, 150, 171, 175, 179** ; resistance of strains of *M. domestica* to, **75, 82, 121, 122, 136, 137, 171, 175, 179** ; resistance to, in larvae of *M. domestica*, **136** ; effect of inbreeding and sex on susceptibility of *Drosophila* to, **140, 141** ; ineffective in dusts against louse and mite on fowls, **47, 102** ; ineffective in wash against *Hypoderma*, **102** ; in milk of sprayed cows, **16** ; determination of, in milk and fatty materials, **48** ; solutions of, **75** ; emulsified solutions of, **16, 44, 75** ; in wettable-powder suspensions, **16, 44, 171, 179** ; use of heat-liquefied, **150** ; deposits of, **44, 75, 82, 140, 150, 171, 175, 179** ; vapours of, **44** ; mixtures of other insecticides with, **175, 179** ; synergists with, **75** ; specifications for, **31** ; (and p,p′methoxy-DDT), chemical definitions of, **3.**
2-(3-Methyl-3-butenyl)-2-methylcyclopropanecarboxylic Acid, allethrolone ester of, **124.**
2-(1-Methyl-n-butyl)-4,6-dinitrophenol (see Dinosam).
Methyl-DDT (and p,p′methyl-DDT), chemical definitions of, **3.**
Methyl β-Diethylaminocrotonate, as repellent against Anophelines, **202.**
Methyl-N,N-diisopropyladipamate, clothing treated with, as repellent against mosquitos, **203.**
2-Methyl-2-(2,2-dimethyl)propylcyclopropanecarboxylic Acid, allethrolone ester of, **124.**
2-Methyl-4,6-dinitrophenol (see DNC).
Methyl Eugenol, as synergist for pyrethrum, **165.**

Methyl-parathion, effect of isomerisation on insecticidal and anticholinesterase activity of, **173, 174** ; chemical definition of, **3**.
2-(1-Methylpropenyl)-3,3-dimethylcyclopropanecarboxylic Acid, allethrolone ester of, **124**.
2-(1-Methyl-n-propyl)-4,6-dinitrophenyl (see Dinoseb).
2-(1-Methylvinyl)cyclopropanecarboxylic Acid, allethrolone ester of, **124**.
2-(1-Methylvinyl)-2-methylcyclopropanecarboxylic Acid, allethrolone ester of, **124**.
Methylene Blue, for marking Anophelines, **92**.
Methylenedioxy Groups, relation of, to activity of pyrethrum synergists, **165, 166**.
3,4-Methylenedioxybenzyl n-Propyl Ether, as synergist with allethrin or pyrethrins, **101**.
Mexico, Anophelines of, **168** ; Anophelines and malaria in, **80, 88, 128, 131, 132, 206** ; filarial larvae in *Culicoides guttatus* in, **86** ; *Phlebotomus* in, **63** ; DDT-resistance in *Musca domestica* in, **132**.
M.G.K. 264, **164**.
Mice, *Haemolaelaps mohri* on, in U.S.S.R., **185** ; transmission of tularaemia to, by mites, **184, 200** ; and *Ornithodoros savignyi*, **98** ; not favourable hosts for *Xenopsylla cheopis*, **66** ; low incidence of murine typhus in, **66** ; used in comparisons of toxicity and anticholinesterase activity of thiophosphates, **173**.
microplus, Boophilus annulatus.
microstoma, Vorticella.
microti, Spirochaeta (*Borrelia*) (see *S. crocidurae*).
Microtus, Trombicula akamushi on, in Japan, **194** ; *Ornithodoros erraticus* transmitting spirochaete of, in Persia, **9**.
Microtus arvalis, relation of mites to tularaemia in, in U.S.S.R., **185**.
Milk, insecticides in, from sprayed cows, **16** ; determination of methoxy-DDT in, **48**.
minimus, Anopheles.
minutus, Phlebotomus.
Mites, infesting man, **8, 33, 34, 109** ; infesting domestic animals, **50, 110, 111** ; on fowls, **46, 47, 102, 194** ; on other birds, **194, 195** ; on rats, **8** ; infesting Simuliids, **39** ; experiments with *Litomosoides carinii* and, **7, 12, 33, 51** ; relation of, to tularaemia, **183, 184, 185, 200** ; rate of blood digestion in, **210** ; humidity chamber for maintaining, **51** ; introduction to study of, **22** ; classification and new species of, **194, 195**. (See Trombiculids.)
mohrae, Haemolaelaps.
Molasses, in bait for flies, **145**.
molestus, Culex pipiens.
molitor, Tenebrio.
moluccensis, Anopheles punctulatus (see *A. farauti*).
Monkeys, *Chrysopa silacea* possibly infected with filariae from, in Br. Cameroons, **27** ; new spirochaete in, in Kenya, **97** ; relation of mosquitos and yellow fever to, **10, 24, 25, 59, 80, 93, 94, 146, 147, 171** ; experiments with yellow fever and, **24, 25, 59**.
montanus, Diamanus.
Montenegro, Anophelines and malaria in, **92, 93** ; use of *Gambusia* against Anopheline larvae in, **93**.
monticola, Simulium.
morganii, Proteus.
Morocco, forms and spirochaete relations of *Ornithodoros erraticus* in, **9, 193**.
morsitans, Glossina.
Mosquito Larvae, breeding places of, **9, 12, 13, 15, 16, 43, 49, 53, 57, 78, 79, 80, 92, 93, 94, 96, 103, 114, 115, 117, 119, 127, 146, 167, 168, 170, 188, 189, 190, 204, 207** ; relation of aquatic plants to (see also Algae), **49, 80** ; physico-chemical factors related to, **114, 115, 207** ; reactions to heat of related forms and species of, **145** ; avoidance of water surface by Anopheline, **205, 206** ; rearing and utilisation of predacious species of, **77, 78** ; use of fish against, **93, 146, 190** ; ciliate destroying, **90** ; parasitised by Mermithids, **60** ; traps for, **78, 79, 80** ; larvicides against (see also DDT), **12, 30, 48, 54, 69, 80, 93, 127, 143, 144, 146, 167, 190, 198, 204** ; resistance to larvicides in, **48, 72, 73, 166, 205** ; factors affecting tests of larvicides against, **41, 73** ; other measures against, **93, 103, 127, 190, 191** ; use of, for bioassay of pyrethrins, **62** ; method of mounting, **148**.
Mosquito Pupae, of north-eastern U.S.A., **148** ; insecticides against, **144** ; reactions to heat of related forms and species of, **145**.
Mosquitos*, in French West Africa, **114-116, 181** ; in Algeria, **207** ; of Argentina, **92** ; in Australia, **9, 10** ; in Belgian Congo, **17, 30, 99** ; in Borneo, **57, 58, 118** ; in Brazil, **56, 57, 59, 92, 116** ; in Britain, **119, 120** ; in British

* For relation to disease see under *Acanthocheilonema*, Dengue, Encephalitis, Malaria, *Wuchereria* spp., Yellow Fever.

Honduras, **80** ; in Burma, **57, 58** ; in Canada, **23, 24, 41, 65, 66, 143, 144, 209** ; in Chile, **96** ; in China, **49, 58, 113, 114, 117, 127, 128** ; in Ecuador, **170, 171** ; in Egypt, **119, 206, 207** ; in Formosa, **49, 57** ; in France, **119, 120** ; in Gambia, **116** ; in Germany, **120** ; in Guam, **102, 103, 189, 190** ; in Guatemala, **80** ; in Hawaii, **77, 78** ; in Honduras, **80** ; in Hong Kong, **94** ; in India, **10-12, 57, 58** ; in Indo-China, **57, 58** ; in Indonesia, **57, 58, 118** ; in Italy, **30, 60, 146, 205** ; in Japan, **173** ; in Kenya, **153** ; in Liberia, **53** ; in Malaya, **58, 116-118, 162, 163** ; in Mauritius, **146** ; in Mexico, **80, 88, 128, 131, 168, 206** ; in Nicaragua, **80** ; in Nigeria, **115** ; in Okinawa, **173, 188** ; in southern Pacific islands, **161** ; in Panama, **25, 26, 56, 78-80, 131, 202** ; in Peru, **89, 90** ; in Philippines, **117, 172** ; in Porto Rico, **91, 92** ; in N. Rhodesia, **167, 168** ; of Sakhalin, **83** ; in Sardinia, **205, 206** ; in Sudan, **190** ; in Trinidad, **15, 16, 118, 203, 211** ; in Uganda, **10, 24, 25, 93, 94, 147, 161** ; in U.S.A., **15, 43, 47, 48, 49, 54, 55, 56, 60, 65, 66, 72, 73, 80, 88, 89, 90, 106, 127, 131, 144, 148, 152, 153, 166, 167, 168, 204** ; of California, **168** ; in Venezuela, **32** ; in Yugoslavia, **92, 93, 163** ; relation of, to domestic animals, **88, 89, 94, 113, 115, 117, 162, 163, 189, 190** ; factors affecting activity and feeding of, **23** ; responses of, to visual stimuli, **37** ; precipitin-test studies of rate of blood digestion in, **209, 210** ; factors affecting identification of blood in, by precipitin test, **208** ; resting places of, **56, 88, 91, 92, 115, 116, 117, 162, 173** ; trap shelters for, **56, 91** ; factors influencing eggs and oviposition of, **60, 78, 79, 105, 207** ; effects of temperature and humidity on, **23, 114, 115, 163, 164** ; spiracle size indicating humidity requirements of, **84** ; hibernation of, **23, 119, 131, 163, 205** ; flight-range of, **92, 127** ; marked with radioactive phosphorus from flowers, **23** ; rate of development and ratio of sexes of, **36** ; rearing of, **106** ; repellents against, **72, 202, 203** ; aerosols against, **10, 24, 31, 127, 143, 172, 173** ; BHC against, **10, 11, 31, 57, 128, 153, 154, 155, 156, 178** ; tests and uses of DDT against, **10-12, 23, 24, 30, 31, 41, 42, 53, 54, 57, 58, 60, 76, 80, 88, 89, 92, 128, 131, 143, 152-155, 156, 172, 173, 178, 198, 205, 206** ; deposits of other insecticides against, **148, 153, 154, 155, 156, 198** ; sprays containing other insecticides against, **10, 11, 31, 45, 164** ; controlled by vaporised insecticides, **76** ; effects on, of dusting against cotton pests, **144** ; carriage and control of, in aircraft, **200, 201** ; bulletins on uses of aircraft, ground equipment and insecticides against, **30, 31** ; technique of topical application of insecticides to, **178** ; effects of insecticides and irritant vapours on oviposition by, **105, 106** ; resistance to insecticides in, **47, 48, 72, 73, 127, 152, 166, 197** ; classification and new species of, **15, 17, 32, 92, 96, 112, 115, 116, 117, 119, 146, 161, 191, 212** ; complexes of subspecies or related species of, **15, 116, 119-121, 191, 206, 207** ; hybridisation of species or subspecies and forms of, **15, 119, 120** ; cytological basis of inheritance in, **119, 120** ; methods of naming members of complexes of, **116, 117** (and note), **119** ; survey of data on, **197** ; use of eggs of, for rearing Trombiculids, **4.**

Mosquitos (Anopheline), of Indo-Australian Region, **191** ; of Madagascar, **190.**

moubata, Ornithodoros.

moucheti, Anopheles.

Mus musculus (see Mice).

Musca domestica, in Denmark, **123** ; in Italy, **60, 81, 122, 158** ; in Mexico, **132** ; in Sardinia, **71, 121, 158** ; in Siberia, **199** ; in Switzerland, **71, 199** ; in Uruguay, **122** ; in U.S.A., **42, 44, 47, 74, 75, 76, 126, 135, 136, 137, 145, 171, 174, 175, 178** ; effect of control of, on incidence of diarrhoeal diseases, **126** ; experiments on relation of, to enteric bacteria, **187, 188** ; normal bacterial flora of, **188** ; observations on dispersal of, **42, 43, 107** ; marking of, with radioactive phosphorus, **42, 108, 187** ; fly-grills for measuring populations of, **126** ; trap for, **44** ; carriage of, in aircraft, **200** ; observations on oviposition by, **105, 142** ; reactions to moisture of larvae of, **199** ; effects of temperature and type of dung on development of, **199, 200** ; tests and uses of BHC against, **43, 44, 121, 123, 137, 150, 156, 171, 175** ; tests and uses of DDT against, **43, 44, 53, 60, 70, 71, 74, 75, 76, 126, 132, 137, 150, 151, 156, 175, 204, 206, 208** ; effects of temperature on action of DDT on,

140 ; absorption and distribution of DDT in, **122, 176, 208** ; tests and uses of other insecticides against adults of, **43, 44, 47, 60, 61, 62, 69, 70, 71, 74, 75, 101, 107, 121, 123, 124, 125, 126, 135, 137, 145, 150, 156, 164, 165, 166, 171, 175, 178, 179, 198, 199, 204, 206** ; poison baits for, **145, 171** ; responses of, to vapours of chlorinated hydrocarbons, **44** ; action of synergist for pyrethrins against, **61, 62** ; tests of insecticides against larvae of, **36, 69, 71, 81, 135, 136, 198** ; DDT-resistant strains of, **60, 69, 70, 71, 74, 75, 76, 81, 82, 121-124, 126, 132, 136, 137, 138, 140, 145, 156, 158, 159, 171, 174-177, 199, 204, 206, 209** ; forms and mechanisms of DDT-resistance in, **123, 159, 176** ; factors affecting assessment of DDT-resistance in, **122, 176** ; resistance or reactions of strains of, to other insecticides, **60, 69, 70, 71, 74, 75, 82, 121-124, 126, 136, 137, 138, 159, 171, 174, 175, 179, 199, 204** ; experimental production and loss of insecticide-resistance in, **74, 75, 81, 123, 158, 159, 174, 175** ; studies on inheritance of insecticide-resistance in, **122, 123, 124** ; importance of larval exposure and production of insecticide-resistance in, **136** ; synergists for insecticides against resistant strains of, **74, 75, 138, 206** ; survey of resistance to insecticides in, **197** ; used for bio-assay of insecticides, **70, 108** ; used in comparisons of toxicity and anti-cholinesterase activity of thiophosphates, **173, 174** ; not repelled by tufts of cotton-wool, **47** ; technique and apparatus for testing insecticide deposits against, **135, 174** ; methods of testing atomised sprays against, **135, 142, 198** ; method of suspending, for tests of airborne insecticides, **76** ; techniques for topical application of DDT to, **122, 208** ; technique of rearing, **81, 109, 145, 187** ; cage for, **109** ; mounting of living, on paraffin blocks, **188.**

Musca nebulo, in India, **94** ; question of resistance to DDT in, **94, 95, 124.**

mutans, Cnemidocoptes.

N

Natural Gas, attraction of blowflies by, **142.**

neavei, Simulium.

nebulo, Musca.

nebulosus, Culex.

neghmei, Anopheles pseudopunctipennis.

neomaculipalpus, Anopheles.

Neotoma fuscipes, Anopheline hibernating in nests of, in California, **131.**

Neotoma micropus (in U.S.A.), fleas on, **171, 172** ; Q fever in, **51.**

Neotran (see Di(p-chlorophenoxy)methane).

New Guinea, *Haematopinus quadripertusus* on cattle in, **180.**

New Zealand, interception and control of insects arriving in aircraft in, **200, 201.**

Nicaragua, *Anopheles crucians* in, **80** ; *Dermatobia hominis* on cattle in, **34, 35, 109** ; tick on cattle in, **35.**

Nicotine, used in test of action of Pyrolan, **70.**

Nicotine Sulphate, in dressings and dips against *Dermatobia hominis*, **35** ; in sprays against mite on fowls, **102.**

Nigeria, Anophelines in, **115** ; *Chrysops* spp. in, **28, 160** ; *Loa loa* in, **28.**

nigerrimus, Anopheles hyrcanus.

nigromaculis, Aëdes.

nili, Anopheles.

nocturnus, Aëdes vexans.

noei, Anopheles pseudopunctipennis.

nölleri, Simulium.

2,4-Nonanediol, treatment of clothing with, as repellent against mosquitos, **203.**

Nopco 1216, in concentrate for producing DDT suspension, **54.**

normandi, Spirochaeta (*Borrelia*).

Norway Rats (see *Rattus norvegicus*).

Nosopsyllus fasciatus, on rats in U.S.A., **32, 132, 133** ; and plague, **132, 133** ; not associated with outbreaks of murine typhus, **133** ; experiments with *Rickettsia burneti* and, **192.**

novyi, Spirochaeta (*Borrelia*).

NPD (see Tetra-n-propyl Dithionopyrophosphate).

nubeculosus, Culicoides.

nuttalli, Laelaps.

Nyssorhynchus (see *Anopheles*).

O

oakleyi, Aëdes.

occidentalis, Dermacentor.

ochraceum, Simulium.

Octachlorohexahydromethanoindene (see Chlordane).

Octachlorotetrahydroendomethyleneindan [or methanoindan] (see Chlordane).

Octa-Klor (see Chlordane).

Octamethyl Pyrophosphoramide (see Schradan).
n-Octyl Sulphoxide of Isosafrole, as synergist with allethrin or pyrethrins, **101.**
Oils, in aerosol formulae, **211** ; as carriers for insecticide sprays, **10, 41, 74, 82, 101, 107, 124, 125, 135, 142** ; methods of applying sprays based on, from helicopters, **141** ; as solvents for DDT, **23, 30, 31, 41, 44, 52, 54, 71, 122, 156, 157, 211, 212** ; as solvents for other organic insecticides, **44, 70, 71, 156, 157, 211** ; effects of types of, as solvents for applying insecticide deposits, **44** ; uses of DDT in, against mosquito larvae, **12, 23, 41, 80, 103, 172** ; other mosquito larvicides applied in, **12, 80** ; pools treated with, to catch Tabanids, **18** ; ineffective in emulsions against *Culicoides* larvae, **136.**
Oils, Essential, as synergists for pyrethrum, **165.**
Okinawa, mosquitos in, **173, 188** ; mosquito-borne diseases in, **188.**
OMPA (see Schradan).
Onchocerca, survey of literature on, **14.**
Onchocerca caecutiens (see *O. volvulus*).
Onchocerca cervicalis, development of, in *Culicoides nubeculosus*, **100** ; possibly identical with *O. reticulata*, **100.**
Onchocerca reticulata, investigations on vector of, in horses in France, **100** ; *O. cervicalis* possibly identical with, **100.**
Onchocerca volvulus, **99** ; in Belgian Congo, **13, 29, 98, 111, 201, 202** ; in Gold Coast, **29, 147** ; in Guatemala, **15, 86** ; in Mexico, **86** ; in Sudan, **38, 39** ; experiments with *Culicoides* and, **86** ; Simuliids transmitting, **15, 28, 29, 38, 39, 111, 147, 201, 202** ; development of, in Simuliids, **13, 39, 201** ; effect of length of exposure on danger from, **28, 29.**
Oncopeltus fasciatus, metabolism of DDT by, **123.**
Orchopeas sexdentatus, DDT against, on *Neotoma micropus* in U.S.A., **171, 172.**
Organic Compounds, tests of, as potential insecticides, **124, 125** ; mode and mechanism of action of, on insects, **49, 61, 64, 122, 173, 208, 209** ; relation of molecular structure to insecticidal action of, **74, 125, 155, 173** ; bioassay of, **48, 62, 70, 108** ; analysis of chlorinated, by partition chromatography, **112.**
Oriental Region, Anophelines of, **191.**
orientalis, Blatta ; Rickettsia.
ornatum, Simulium.
Ornithodoros, distribution of Old World species of, **212** ; possible adaptation of spirochaetes of, to *Pediculus humanus*, **182** ; toxicity of Pyrolan to, **69.**
Ornithodoros brasiliensis, in Brazil, **133, 134** ; new spirochaete in, **134** ; bionomics and ecology of, **133, 134.**
Ornithodoros canestrinii, resistance of, to starvation, **186.**
Ornithodoros erraticus, new spirochaete in, in gerbil burrows in Kenya, **9** ; distribution and spirochaete-relations of forms of, **9, 193.**
Ornithodoros erraticus var. *sonrai*, **193.**
Ornithodoros hermsi, transmitting relapsing fever in California, **133** ; experiments with relapsing fever and, **133** ; hosts and ecology of, **133.**
Ornithodoros lahorensis, on sheep in Yugoslavia, **18** ; not a vector of relapsing fever, **18** ; resistance of, to starvation, **186.**
Ornithodoros moubata, in East Africa, **8, 9, 97, 98, 130** ; in French Congo, **169** ; transmitting relapsing fever, **97, 98, 130** ; experiments with *Spirochaeta duttoni* and, **95, 96, 97, 98** ; experiments with other spirochaetes and, **9, 97, 169** ; experiments with *Rickettsia burneti* and, **192** ; rate of blood digestion in, **210** ; in animal burrows, **8, 9** ; not found on rats, **98** ; relation of, to fowls, **130** ; effect of climate and type of hut on prevalence of, **130** ; BHC against, in huts, **130** ; laboratory tests of toxicity of insecticides to, **156, 199.**
Ornithodoros papillipes (see *O. tholozani*).
Ornithodoros parkeri, in U.S.A., **134** ; identification of, by biological criteria and relation to spirochaetes and rickettsiae, **134, 135** ; synonymy of, **134.**
Ornithodoros savignyi, in French Congo, **169** ; in Kenya and British Somaliland, **97** ; question of relation of, to *Spirochaeta duttoni*, **97, 98** ; experiment with *S. dipodilli* and, **9** ; experiments with rats or mice and, **98.**
Ornithodoros talaje, experimentally infected with Q fever, **51.**
Ornithodoros tartakovskyi, resistance of, to starvation, **186** ; small form of *O. erraticus* probably identical with, **193.**
Ornithodoros tholozani, in U.S.S.R., **20, 185** ; experiments with relapsing fever and, **185, 186** ; longevity and resistance to starvation of, **185, 186** ; survival of, under plaster, **20.**
Ornithodoros turicata, O. parkeri recorded as, in California, **134** ; in Mexico, **134** ; identification of, by biological criteria

and relation to spirochaetes and rickettsiae, **134, 135.**
Ornithodoros verrucosus, resistance of, to starvation, **186.**
Ornithodoros wheeleri (see *O. parkeri*).
oswaldoi, *Phlebotomus.*
Otobius megnini, on cattle in U.S.A., **51** ; Q fever not found in, **51.**
ovale, *Plasmodium.*
ovinus, *Melophagus.*
ovis, *Psorergates ; Psoroptes.*
Ovotran (see p-Chlorophenyl p-Chlorobenzenesulphonate).
ozzardi, *Mansonella* (*Filaria*).

P

P 520, **153.**
P 530, **153.**
pacificus, *Ixodes.*
Pack Rats (see *Neotoma*).
Pakistan, new sandfly recorded as *Phlebotomus minutus* in, **40** ; tick-borne relapsing fever in, **51** ; association of *Argas persicus* with wild birds and trees in, **210.**
palestinensis, *Phlebotomus* (*Sergentomyia*).
pallens, *Culex pipiens.*
pallescens, *Lucilia* (*Phaenicia*) (see *L. cuprina cuprina*).
pallidipes, *Glossina.*
palpalis, *Glossina.*
paludis, *Anopheles.*
Panama, *Anopheles albimanus* in, **56, 131, 202** ; experiments with Anophelines and strains of *Plasmodium falciparum* from, **56, 131** ; other mosquitos and yellow fever in, **25, 26, 78-80** ; *Culicoides* spp. in, **32, 85.**
pandani, *Aëdes.*
papatasi, *Phlebotomus.*
papillipes, *Ornithodoros* (see *O. tholozani*).
paraensis, *Culicoides.*
Paraoxon, chemical definition of, **3.**
Parasitology, Tropical, books on, **169.**
Parathion, against *Cimex lectularius*, **149** ; toxicity of, to fleas, **87** ; unsatisfactory against *Dermatobia hominis*, **35** ; susceptibility to, of mosquito larvae resistant to other insecticides, **48** ; reactions of strains of *Musca domestica* to, **82, 137, 174, 175** ; against ticks, **180, 181, 190** ; in dips, **35** ; in dusts, **87** ; in ointment, **35** ; in sprays, **149, 180, 181** ; toxicity of, on treated surfaces, **149** ; toxicity of, to rodents, **35, 198** ; question of risk of, to man, **149** ; Diazinon compared with, **198, 199** ; effect of isomerisation on insecticidal and anticholinesterase activity of, **173, 174** ; proportions of isomers in technical, **174** ; methods of determination of, **48** ; chemical definition of, **3** ; methyl homologue of (see Methylparathion) ; oxygen analogue of (see Paraoxon).
Parcoblatta pensylvanica, unusual infestation by, in S. Dakota, **107.**
Paris Green, in dust against Anopheline larvae, **146** ; ineffective against *Culicoides* larvae, **136.**
parkeri, *Ornithodoros ; Spirochaeta* (*Borrelia*).
parva, *Theileria.*
Passer domesticus (see Sparrows).
pecorum, *Gasterophilus.*
pedalis, *Linognathus.*
Pedicinus longiceps, experiments with spirochaetes and, **9, 97.**
Pediculus corporis (see *P. humanus humanus*).
Pediculus humanus capitis, *Spirochaeta duttoni* in, in Kenya, **97** ; not resistant to DDT in Korea, **106** ; experiments with *Rickettsia* spp. and, **148.**
Pediculus humanus humanus L., in Britain, **159** ; in Egypt, **157, 159, 160** ; transmitting relapsing fever in Kenya, **97** ; in Korea, **106, 159, 160** ; experiments with rickettsiae and, **101, 192** ; other lice infected with rickettsiae from, **148** ; experiments with tick-borne spirochaetes and, **9, 97, 98, 181, 182** ; *Spirochaeta harveyi* not infecting, **97** ; DDT-resistant strains of, **106, 157, 159, 160** ; mechanism of DDT resistance in, **159** ; tests and use of various insecticides against susceptible and resistant strains of, **106, 156, 157, 159, 199.**
Pediculus humanus humanus, auct. (see *P. h. capitis*).
peditaeniatus, *Anopheles hyrcanus.*
Peet-Grady Method, revisions of, **198** ; turntable modification of, **135.**
penetrans, *Tunga* (*Sarcopsylla*).
Penicillin, effect of, on *Spirochaeta duttoni*, **98.**
pensylvanica, *Parcoblatta.*
perfidiosus, *Culex.*
Perilampus, parasite of *Simulium damnosum* in Sudan, **39.**
Periplaneta americana, experiments with Coxsackie virus and, **86** ; used for tests of toxicity of insecticides, **42, 69, 143, 198** ; lipase of, in relation to pyrethrins, **62** ; radioactive tracer study of distribution and metabolism of pyrethrins in, **177, 178.**

Periplaneta australasiae, toxicity of vaporised lindane to, **42.**
Peromyscus maniculatus bairdii, experiment with *Aëdes aegypti* and, **37.**
Persia, form and spirochaete of *Ornithodoros erraticus* in, **9, 193** ; investigations on blood parasites of animals in, **169.**
persica, *Spirochaeta* (*Borrelia*).
persicus, *Argas*.
perstans, *Acanthocheilonema* (*Filaria*).
Peru, *Anopheles pseudopunctipennis* and malaria in, **89, 90.**
Phaenicia (see *Lucilia*).
Phenol Ethers, relation of structure to activity of, as synergists for pyrethrum, **166.**
2-Phenylcyclohexanol, against *Dermatophagoides*, **34** ; as repellent against *Stomoxys calcitrans*, **34.**
1-Phenyl-3-methyl-pyrazolyl(5) Dimethyl Carbamate (see Pyrolan).
philippinensis, *Anopheles*.
Philippines, *Latrodectus geometricus* and its natural enemies in, **65** ; mosquitos in, **117, 172.**
Phlebotominae, of Ethiopian Region, **17** ; of Iraq, **40** ; classification of, **17, 40.**
Phlebotomus, key to females of American species of, **112** ; of Ethiopian Region, **17** ; of Iraq, **40** ; in U.S.S.R., **19, 184** ; determination and relation to *Leishmania tropica* of repeated gonotrophic cycle of, **184** ; breeding in burrows of gerbils and birds, **19** ; scope and classification of, **17, 40, 63, 64** ; survey of data on, **17.**
Phlebotomus africanus, proposed suppression of name, **17.**
Phlebotomus alexandri, breeding in gerbil burrows in Turkmenistan, **19.**
Phlebotomus antennatus, varieties of, recorded as *P. minutus* in Ethiopian Region, **17.**
Phlebotomus argentipes, occurrence of, in absence of visceral leishmaniasis in Mysore, **128.**
Phlebotomus baduelensis, status and synonymy of, **63.**
Phlebotomus caucasicus, breeding in gerbil burrows in Turkmenistan, **19** ; determination of repeated gonotrophic cycle in, **184.**
Phlebotomus chinensis, breeding in gerbil burrows in Turkmenistan, **19.**
Phlebotomus cruciatus, sandfly recorded as, in Mexico and Guatemala, **63** ; considered a *nomen nudum*, **63.**
Phlebotomus dentatus, breeding in gerbil burrows in Turkmenistan, **19.**
Phlebotomus freetownensis, recorded as *P. africanus*, **17.**
Phlebotomus gomezi, synonymy of, **63.**
Phlebotomus japignyi, considered distinct from *P. gomezi*, **63.**
Phlebotomus minutus, sandflies recorded as, in Ethiopian Region and Pakistan, **17, 40.**
Phlebotomus minutus var. *arpaklensis* (see *P. dentatus*).
Phlebotomus oswaldoi, **63.**
Phlebotomus palestinensis, in Iraq, **40** ; males of, **40.**
Phlebotomus papatasi, associated with dry soil in Iraq, **40** ; breeding in gerbil burrows in Turkmenistan, **19** ; determination of repeated gonotrophic cycle in, **184.**
Phlebotomus rorotaensis, in French Guiana, **63** ; status and female of, **63, 64.**
Phlebotomus sergenti, probably transmitting *Leishmania tropica* in Iraq, **40** ; breeding in gerbil burrows in Turkmenistan, **19** ; determination of repeated gonotrophic cycle in, **184** ; soil water level affecting distribution of, **40.**
Phlebotomus sergenti alexandri (see *P. alexandri*).
Phlebotomus (*Sergentomyia*) *sintoni*, sp. n., in Iraq and Pakistan, **40.**
Phlebotomus squamipleuris, considered identical with *P. africanus*, **17.**
Phlebotomus suis, considered a synonym of *P. gomezi*, **63.**
Phlebotomus trinidadensis, divergent views on synonymy of, **63.**
Phlebotomus villelai, considered a synonym of *P. baduelensis*, **63** ; *P. rorotaensis* distinct from, **64.**
Phlebotomus yucatanensis, status and type of, **63.**
Phormia regina, in U.S.A., **143, 172** ; attracted by natural gas, **143** ; dispersal habits of, **172** ; methods of marking, with radioactive phosphorus, **108, 172** ; cage and rearing media for, **109** ; physiological effects of DDT on larvae of, **49.**
Phosphorus, Radioactive, flies marked with, **42** ; methods of marking flies with, **108, 172, 187** ; uptake of, by mosquitos from flowers, **23.**
Phthirus pubis, experiments with *Rickettsia* spp. and, **148.**
Phyllodromia germanica (see *Blattella*).
pictus, *Dermacentor*.
Pigeons, effect on, of lindane vapour controlling lice, **108.**

Pigs, encephalitis virus in, in China, **128** ; Anophelines attracted by, **89, 94** ; *Haematopinus suis* on, **110** ; rate of development of *Musca domestica* in dung of, **199, 200.**
pilae, *Cnemidocoptes.*
Pine Oil, smear of BHC and, against *Dermatobia hominis*, **35, 109.**
Pinene Ethers, of glycols (see under Glycol and Ethylene Glycol).
Piperonyl Butoxide (as synergist), with allethrin, **71, 72, 204** ; with other chrysanthemum acid esters of allethrolone, **72** ; with pyrethrum extracts, **61, 62, 71, 72, 87, 102, 164, 204** ; with separated components of pyrethrum extract, **71, 72** ; with rotenone, **102** ; investigations of action of, **61, 62, 164** ; stoichiometric relations of, with pyrethrins, **164** ; chemical definition of, **3.**
Piperonyl Cyclonene, affecting action of DDT on *Musca domestica*, **176** ; as synergist for pyrethrum, **164** ; stoichiometric relations of, with pyrethrins, **164** ; and rotenone, **101** ; chemical definition of, **3.**
pipiens, *Culex.*
Piroplasmosis (see *Theileria*).
Plague, in U.S.A., **64, 132, 133, 171** ; and fleas, **64, 132, 133, 171, 191, 192;** experiments with fleas and, **64, 85** ; and rats, **64, 132, 133, 191, 192** ; and other rodents, **64, 132, 133, 171.**
Plants, pyrethrum adjuvants derived from Australian, **165** ; mosquitos breeding in water held by, **103, 190.** (See Bromeliads.)
Plasmodium, Anophelines associated with, in bats in Belgian Congo, **30.**
Plasmodium falciparum, in Australia, **9** ; in Liberia, **53** ; experiments with *Anopheles* spp. and American strains of, **56, 131.**
Plasmodium gallinaceum, experiments with mosquitos and, **89, 169, 170.**
Plasmodium lophurae, developing in *Anopheles quadrimaculatus*, **89.**
Plasmodium malariae, in Liberia, **53.**
Plasmodium ovale, in Liberia, **53.**
Plasmodium praecox (*relictum*), in birds in U.S.A., **89** ; experiments with Anophelines and, **89, 203.**
Plasmodium vivax, in Australia, **9** ; in Liberia, **53** ; in Mexico, **206** ; in Okinawa, **188** ; in U.S.A., **90** ; experiments with *Anopheles* spp. and, **90.**
Plexiglas, not damaged by melted DDT, **151.**
Ploughing, effect of, on *Dermacentor* spp., **67.**
plumbeus, *Anopheles.*
Plusia gamma (see *Autographa*).
Poephagus grunniens (see Yak).
Polygenis gwyni, on domestic and field rodents in U.S.A., **64** ; experiments with plague and, **64, 85** ; blood digestion in, **85.**
polynesiensis, *Aëdes.*
Polyplax spinulosa, on rats in U.S.A., **32.**
Population Studies, determination of rates of increase of insects in, **168.**
Porcupines, *Ornithodoros moubata* associated with, in Kenya, **8, 9** ; *Spirochaeta duttoni* not found in, **9.**
Porto Rico, *Culicoides* spp. in, **32, 76** ; mosquitos in, **91, 92** ; malaria in, **91.**
Potamochoerus porcus, yellow fever in, in Uganda, **93.**
Potamon niloticum, immature stages of Simuliids attached to, in Kenya and Uganda, **111.**
Potamonautes spp., attachment of immature stages of Simuliids to, in Belgian Congo, **62, 111, 112.**
praecox, *Plasmodium.*
Precipitin Tests, for identifying blood meals of Diptera, **208** ; for studying rate of digestion of blood in arthropods, **209, 210** ; factors affecting performance of, **208.**
prolixus, *Rhodnius.*
2-Propenylcyclopropanecarboxylic Acid, allethrolone ester of, **124.**
Propyl N,N-Diethylsuccinamate, in repellent mixtures against mosquitos, **72.**
n-Propyl Isome, as synergist for pyrethrum, **164** ; stoichiometric relations of, with pyrethrins, **164** ; chemical definition of, **164.**
n-Propyl Maleate, n-propyl isome a condensation product of isosafrole and, **164.**
2-n-Propyl-4-methyl-pyrimidyl(6) Dimethyl Carbamate (see Pyramat).
Proteus morganii, in *Musca domestica*, **188.**
prowazekii, *Rickettsia.*
Pseudogyps bengalensis, *Argas persicus* associated with, in Pakistan, **210.**
pseudopunctipennis, *Anopheles.*
pseudoscutellaris, *Aëdes.*
pseudosinensis, *Anopheles hyrcanus.*
Psorergates ovis, on sheep in U.S.A., **50.**
Psorophora, aestivation of larvae of, in Porto Rico, **91** ; in U.S.A., **144** ; effects on, of dusting against cotton pests, **144.**
Psoroptes bovis, on cattle in U.S.S.R., **111** ; dixanthogen preparation against, **111.**

Psoroptes equi, on horses in U.S.S.R., **111** ; dixanthogen preparation against, **111**.
Psoroptes ovis, SK-9 in dips against, on sheep in U.S.S.R., **110**.
Psychoda alternata, **172**.
pubis, *Phthirus*.
pulcherrimus, *Anopheles*.
Pulex irritans, insecticide treatment of houses against, in Egypt, **157** ; on rats in U.S.A., **32**.
punctipennis, *Anopheles*.
punctulatus, *Anopheles*.
pusio, *Hippelates*.
Pyramat, against *Musca domestica*, **179** ; composition and properties of, **179** ; and methoxy-DDT, **179**.
Pyrazothion, inhibition of cholinesterase by, **198** ; identity of, **198**.
Pyrazoxon, inhibition of cholinesterase by, **198** ; identity of, **198**.
Pyrethrin I, **74, 101** ; toxicity to *Musca domestica* of, alone and with piperonyl butoxide, **71, 72** ; ratio of other active esters of pyrethrum extract to, **72**.
Pyrethrin II, toxicity to *Musca domestica* of, alone and with piperonyl butoxide, **71, 72** ; ratio of other active esters of pyrethrum extract to, **72**.
Pyrethrins, new test for, **64** ; chromatographic separation of, **168** ; separation and detection of insecticides of type of, **32** ; related esters compared with, **45, 47, 71, 72, 74**. (See Pyrethrum.)
Pyrethrum (including extracts), use of *Calandra granaria* in tests with, **164** ; experimentally acquired resistance to, in *C. granaria*, **165** ; against fleas, **87, 156, 157** ; not increasing effectiveness of cubé against *Hypoderma*, **102** ; against mosquitos, **31, 45, 156, 164** ; repellent effect of, on mosquitos, **10** ; against *Musca domestica*, **61, 62, 71, 72, 74, 101, 107, 124, 125, 135, 137, 156, 165, 166, 171, 204** ; reactions of strains of *M. domestica* to, **122, 137, 159** ; toxicity to *M. domestica* of individual components of, **71, 72** ; against DDT-resistant and susceptible strains of *Pediculus humanus*, **106, 156, 157, 159** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157** ; radioactive tracer study of distribution and metabolism of, in cockroaches, **177, 178** ; evidence of enzymatic detoxification of, in insects, **62** ; in aerosols, **10, 137, 204**; in dusts, **87, 106** ; in sprays, **10, 31, 45, 71, 72, 74, 101, 107, 124, 125, 135, 137, 164, 165, 166, 171** ; deposits of, **61, 62, 156, 157, 159, 164** ; and allethrin, **106** ; and DDT, **31, 106, 204** ; and dinitroanisole, **106** ; and thiocyanate, **204** ; piperonyl butoxide as synergist for, **61, 62, 71, 72, 87, 102, 164, 204** ; other synergists with, **101, 164-166, 204** ; modes of action and chemical structure of synergists for, **61, 62, 71, 164, 165, 166** ; bioassay of, **62** ; effect of test method on relative toxicity of allethrin and, in fly-sprays, **135**. (See Pyrethrins.)
Pyretophorus (see *Anopheles*).
Pyrolan, against resistant and susceptible strains of *Musca domestica*, **69, 70, 71, 179** ; toxicity of, to other arthropods, **69, 156** ; composition and properties of, **69, 179** ; mode of insecticidal action of, **69, 70** ; low toxicity of, to mammals, **69** ; and DDT or methoxy-DDT, **70, 71, 179**.
Pyrophyllite, as carrier for DDT, **31, 171**.

Q

Q Fever (*Rickettsia burneti*), in U.S.A., **51** ; animals infected with, **51** ; experiments with arthropods and, **51, 192**.
quadrimaculatus, *Anopheles*.
quadripertusus, *Haematopinus*.
Quail, *Trombicula* on, in Malaya, **6**.
Quartan Malaria (see *Plasmodium malariae*).
quinquefasciatus, auct., *Culex* (see *C. pipiens fatigans*).
quintana, *Rickettsia*.

R

Rabbits, development of *Dermatobia hominis* in, **35**.
Radioactive Tracer Methods, for marking flies, **42, 108, 172, 187** ; for marking other insects, **108** ; for studying feeding of mosquitos from flowers, **23** ; for studies of insecticides, **140, 177, 178**.
Rats, fleas on, **31, 32, 64, 132, 133, 191, 192** ; mice compared with, as hosts for *Xenopsylla cheopis*, **66** ; DDT against fleas on, **191** ; warfarin not affecting fleas on, **32** ; and *Ornithodoros* spp., **98** ; *Polyplax spinulosa* on, **32** ; Trombiculids on, **4, 5, 6, 7, 194** ; use of, for collecting Trombiculids, **5, 6** ; other mites on, **8, 32** ; and plague, **64, 132, 133, 191, 192** ; and relapsing fever spirochaetes, **98** ; and tsutsugamushi disease, **4, 5, 31, 194** ; and murine typhus, **32, 132, 133** ; experiments with murine typhus and, **132**.

Rattus (see Rats).
Rattus edwardsi, *Rickettsia orientalis* in, in Malaya, **31**.
Rattus mülleri (in Malaya), *Trombicula deliensis* on, **7** ; *Rickettsia orientalis* in, **31**.
Rattus norvegicus, **8** ; fleas on, in U.S.A., **32, 64** ; and plague, **64**.
Rattus rajah, **31**.
Rattus rattus, in Bengal, **5** ; *Bdellonyssus bacoti* on, in Britain, **8** ; *Spirochaeta duttoni* not found in, in Kenya, **98** ; in Malaya, **7** ; fleas on, in U.S.A., **32** ; mice compared with, as hosts for *Xenopsylla cheopis*, **66** ; experiments with murine typhus and, **132** ; association of Trombiculids and tsutsugamushi disease with, **5, 7, 194**.
Rattus rattus kijabius, experimentally infected with *Spirochaeta duttoni*, **98**.
recurrentis, *Spirochaeta* (*Borrelia*).
reflexus, *Argas*.
regina, *Phormia*.
Relapsing Fever, in East Africa, **97, 98, 130** ; in India and Pakistan, **50, 51** ; in U.S.A., **133, 134** ; absence of tick-borne, in Yugoslavia, **18** ; and ticks, **50, 51, 97, 98, 130, 133, 134, 193** ; experiments with ticks and, **95, 97, 98, 133, 185, 186** ; differentiation of *Ornithodoros* spp. by relations to spirochaetes of, **134** ; not transmitted by *O. lahorensis*, **18** ; and *Pediculus*, **97** ; question of transmission by *Pediculus* of tick-borne spirochaetes of, **97, 98, 181, 182** ; doubtful relation of *Cimex hemipterus* to, **97, 98** ; and rodents, **98, 133**. (See *Spirochaeta* spp.).
relicta, *Chrysops*.
relictum, *Plasmodium* (see *P. praecox*).
renauxi, *Simulium*.
Repellents, against *Culicoides*, **86** ; against fleas, **203** ; against mosquitos, **72, 202, 203** ; against Simuliids, **39, 147, 201** ; against *Stomoxys calcitrans*, **34** ; against Tabanids, **160** ; against ticks, **203** ; against Trombiculids, **203** ; treatment of clothing with, **203**.
reptans, *Simulium*.
Resin, effect of, in DDT deposit-sprays, **150, 151**.
restuans, *Culex*.
reticulata, *Onchocerca*.
Reviews : Baker (E.W.) & Wharton (G.W.), An Introduction to Acaralogy, **22** ; Bonne-Wepster (J.) & Swellengrebel (N.H.), The Anopheline Mosquitoes of the Indo-Australian Region, **191** ; Covell (Sir G.), Russell (P.F.) & Swellengrebel (N.H.), Malaria Terminology, **116** ; de Ong (E. R.), Insect, Fungus and Weed Control, **77** ; Doucet (J.), Les anophélinés de la région malgache, **190** ; Eichler (W.), Methods of treating parasitic Insects, **12** ; Fisher (R. A.) & Yates (F.), Statistical Tables for biological, agricultural and medical Research (4th edn., revd.), **213** ; Holstein (M. H.), Biologie d' *Anopheles gambiae*, **114** ; Houpeau (J.-L.) & Lhoste (J.), Appareils français pour l'épandage d'insecticides sanitaires, **149** ; Martini (E.), A Textbook of Medical Entomology (4th edn., revd.), **113** ; Mertin (J. V.), Pesticides : a Review of their Uses, Properties and Hazards, **77** ; Peterson (A.), A Manual of Entomological Techniques (7th edn.), **213** ; Rivers (T. M.) Ed., Viral and Rickettsial Diseases of Man (2nd edn.), **113** ; Roberts (F. H. S.), Insects affecting Livestock with special Reference to . . . Australia, **112** ; Roeder (K. D.) Ed., Insect Physiology, **148** ; Rosický (B.) & Weiser (J.), Control of Insects, I. Modern Insecticides, **148** ; Rousselot (R.), Notes de parasitologie tropicale (tomes I-II), **169** ; Wharton (G. W.) & Fuller (H. S.), A Manual of the Chiggers . . ., **50** ; Bibliography of Onchocercosis, **14** ; Insects (Yearb. U.S. Dep. Agric. 1952), **197**.
Rhesus Monkey (see *Macaca mulatta*).
Rhipicephalus appendiculatus, experiments with East Coast fever of cattle and, in Uganda, **21**.
Rhipicephalus sanguineus, observations on oviposition, eggs and larvae of, **81**.
Rhodesia, Northern, mosquitos in, **167, 168** ; yellow fever in, **24, 167**.
rhodesiense, *Trypanosoma*.
Rhodnius prolixus, **85** ; experiments with *Rickettsia burneti* and, **192** ; comparison of toxicity of insecticides to, **156**.
Rhombomys opimus, *Phlebotomus* breeding in burrows of, in Central Asia, **19**.
Rhopalopsyllus gwyni (see *Polygenis*).
Rice-fields, mosquitos breeding in, **43, 94, 117, 172, 188, 204** ; other pests in, **43** ; methods of applying insecticides in, **43, 172, 204**.
rickettsi, *Rickettsia*.
Rickettsia, **169** ; book on species of, infecting man, **113**.
Rickettsia burneti (see Q Fever).
Rickettsia conori (see *Rickettsia rickettsi conori*).
Rickettsia mooseri (see Typhus, Endemic).
Rickettsia orientalis, in *Euschöngastia* in Malaya, **31** ; in rats, **4, 5, 31, 194** ; list and discussion of mammals infected

with, **193, 194.** (See Tsutsugamushi Disease.)
Rickettsia prowazekii, experimental infection of *Phthirus pubis* and *Pediculus humanus capitis* with, **148.**
Rickettsia quintana, experimental infection of *Phthirus pubis* and *Pediculus humanus capitis* with, **148.**
Rickettsia rickettsi (see Spotted Fever).
Rickettsia rickettsi conori, experiments with insects and, **101.**
Rickettsia tsutsugamushi (see *R. orientalis*).
rodhaini, *Anopheles.*
rorotaensis, *Phlebotomus.*
Rotary Brush Units, for applying sprays from aircraft, **41, 42.**
Rotenone, effect of, on oviposition by *Aëdes sollicitans*, **105** ; in aerosol and washes against *Hypoderma*, **101, 102** ; susceptibility of insecticide-resistant strain of *Musca domestica* to, **122** ; and pyrethrins, **102** ; synergists with, **101, 102.** (See Cubé and Derris.)
Rucide, DDT dips prepared from, **195.**
rufipes, *Anopheles.*
rumicis, *Aphis.*
Ryania, ineffective in wash against *Hypoderma*, **102.**

S

Sabethes chloropterus, bionomics of, in Panama, **26, 79, 80** ; possible relation of, to yellow fever, **26, 80.**
Sabethes cyaneus, bionomics of, in Panama, **79, 80** ; possible relation of, to yellow fever, **80.**
Sabethoides (see *Sabethes*).
sacharovi, *Anopheles maculipennis.*
Sakhalin, blood-sucking arthropods of, **83** ; absence of malaria in, **83.**
salinarius, *Culex.*
Salmonella, fly control not affecting incidence of, in man in Georgia, **126.**
Salmonella schottmülleri, experiments with *Musca domestica* and, **188.**
Salt (see Sodium Chloride).
Samoa, new mosquito recorded as *Aëdes pseudoscutellaris* in, **161.**
Sandflies (see *Culicoides* and *Phlebotomus*).
sanguineus, *Rhipicephalus.*
Sansevieria nilotica, mosquito breeding in leaf axils of, in Sudan, **190.**
sapphirina, *Uranotaenia.*
Sarcophaga, attracted by natural gas in Arizona, **143.**
Sarcophaga bullata, cage and rearing media for, **109, 145.**
Sarcopsylla penetrans (see *Tunga*).
Sarcoptes bubulus (*bovis*, auct.), tests of dixanthogen preparations against, **111.**
Sarcoptes caballi (*equi*), on horses in U.S.S.R., **111** ; preparation of dixanthogen against, **111.**
Sardinia, Anophelines in, **205, 206** ; insecticide-resistance in strains of *Musca domestica* in, **71, 121, 122, 158.**
savignyi, *Hyalomma* ; *Ornithodoros.*
Scabrin, lack of insecticidal activity of compounds related to, **125.**
Scaly Leg, identity of mites causing, in birds, **194, 195.**
scapularis, *Aëdes.*
scheremetewskyi, *Dermatophagoides.*
schottmülleri, *Salmonella.*
Schradan, chemical definition of, **3.**
schwetzi, *Aëdes.*
Screen Wire, dieldrin-treated strips of, against *Musca domestica*, **175.**
Scrub Typhus (see Tsutsugamushi Disease).
segnis, *Leptopsylla.*
sergenti, *Phlebotomus.*
Sergentomyia, considered a subgenus of *Phlebotomus* (*q.v.*), **17** ; considered a distinct genus, **40.**
sericata, *Lucilia* (*Phaenicia*).
Sesame Oil, sesamin causing activity of, as synergist for pyrethrum, **165.**
Sesamin, as synergist for pyrethrum, **164, 165, 166** ; stoichiometric relations of, with pyrethrins, **164** ; importance of methylenedioxy group in, **165.**
sexdentatus, *Orchopeas.*
Shannoniella, not distinct from *Arribalzagia*, **191.**
Sheep, blowflies infesting, **65, 68, 196** ; factors affecting infestation of, by blowflies, **68** ; louse on, **197** ; effect of infestation by *Melophagus ovinus* on, **73, 139** ; mites infesting, **50, 110** ; ticks on, **16, 18** ; physico-chemical studies of factors affecting dips for, **129.**
Shigella, effect of fly control on incidence of, in man in Georgia, **126.**
Shigella dysenteriae, experiments with *Musca domestica* and, **188.**
Shrews (see *Crocidura coerulea*).
Sigmodon hispidus, flea on, in U.S.A., **64** ; and plague, **64** ; experiments with *Bdellonyssus bacoti* and filaria of, **7, 12, 33, 51.**
silacea, *Chrysops.*
silvestris, *Eretmapodites.*
simpsoni, *Aëdes.*
Simuliids, in Canada, **23, 24, 41, 42** ; factors affecting activity of, **24** ; methods of applying DDT against

adults and larvae of, **24, 41, 42** ; repellents against, **39, 147, 201** ; classification and new species of, **29, 49, 50, 63, 111, 112** ; survey of literature on, **14.**
Simulium, of Belgian Congo, **29, 201** ; in Sakhalin, **83** ; relation of species of, to *Onchocerca volvulus* in tropical Africa, **13, 28, 29, 38, 39, 111, 147, 201** ; not a vector of *O. reticulata*, **100.**
Simulium albivirgulatum, in Belgian Congo, **201, 202** ; *Onchocerca volvulus* not completing development in, **201** ; BHC against larvae of, **202.**
Simulium alcocki var. *violaceum* (see *S. impukane*).
Simulium aureum, breeding places of, in Scotland, **14.**
Simulium callidum, flight-range of, in Guatemala, **15** ; and *Onchocerca volvulus*, **15.**
Simulium columbaczense, breeding places of, in Yugoslavia, **112.**
Simulium damnosum, in French Equatorial Africa, **202** ; in Belgian Congo, **13, 29, 99, 111, 201, 202** ; in Gold Coast, **147** ; in Sudan, **38-39** ; and *Onchocerca volvulus*, **13, 29, 38, 39, 147, 201, 202;** experiments with *O. volvulus* and, **201** ; *Acanthocheilonema perstans* in, **38** ; *A. perstans* and *Dipetalonema streptocerca* not developing in, **99** ; bionomics of, **13, 38-39, 111, 147** ; strain of, not attacking man, **29** ; parasites of, **38, 39** ; measures and precautions against, **39, 147, 201, 202** ; in relation to hydroelectric schemes, **147.**
Simulium equinum, in Japan, **172** ; bionomics of, in Scotland, **14.**
Simulium faini, in Belgian Congo, **201, 202** ; *Onchocerca volvulus* not completing development in, **201** ; BHC against larvae of, **202.**
Simulium griseicolle, differences between forms of, in Gold Coast and Sudan, **147.**
Simulium hirsutum, immature stages of, on *Potamon niloticum* in Uganda, **111.**
Simulium impukane, not attacking man in Gold Coast, **147.**
Simulium latipes, bionomics of, in Scotland, **14.**
Simulium marlieri, sp. n., in Belgian Congo, **49.**
Simulium metallicum, flight-range of, in Guatemala, **15** ; and *Onchocerca volvulus*, **15.**
Simulium monticola, bionomics of, in Scotland, **14, 15.**
Simulium neavi, in Kenya and Uganda, **63, 111** ; *S. renauxi* from Belgian Congo probably conspecific with, **29, 63, 111, 112** ; vector of *Onchocerca volvulus*, **111** ; immature stages of, on *Potamon niloticum*, **111** ; characters of, **50, 63** ; breeding habits and identity of species recorded as, in Belgian Congo, **49, 50, 63, 112.**
Simulium nölleri, in Scotland, **14.**
Simulium ochraceum, flight-range of, in Guatemala, **15** ; and *Onchocerca volvulus*, **15.**
Simulium ornatum, bionomics of, in Scotland, **14, 15.**
Simulium renauxi, sp. n., in Belgian Congo, **29, 62, 63, 111** ; relation of, to *Onchocerca volvulus*, **29, 111** ; attachment of immature stages of, to crabs, **62, 111** ; characters of, **63, 111** ; probably conspecific with *S. neavei*, **63, 111, 112.**
Simulium reptans, bionomics of, in Scotland, **14, 15.**
Simulium tuberosum, breeding places of, in Scotland, **14.**
Simulium unicornutum, not attacking man in Gold Coast, **147.**
Simulium variegatum, bionomics of, in Scotland, **14, 15.**
Simulium venustum, in Canada, **209, 210** ; in Scotland, **14** ; adult populations and activity of, **209, 210.**
sinensis, *Anopheles hyrcanus* ; *Culex.*
sintoni, *Phlebotomus* (*Sergentomyia*).
Sintonius, subgenus of *Phlebotomus* (*q.v.*), **17.**
Sitotroga cerealella, ammonium carbonate stimulating oviposition by, **105.**
SK-9, composition and uses of, against parasites of domestic animals, **110.**
Skunk (see *Conepatus*).
Slaughter-house, blowflies in, **83.**
Sleeping Sickness, importance of hybridisation of trypanosomes in relation to, **26, 27.** (See *Trypanosoma gambiense* and *T. rhodesiense*.)
Smear EQ-335, **35, 109.**
smithii, *Anopheles.*
Soap, with rotenone in wash against *Hypoderma*, **102** ; as wetting agent for nicotine sulphate spray, **102.**
Society Islands, new mosquito recorded as *Aëdes pseudoscutellaris* in, **161.**
Sodium Arsenite, ineffective against *Culicoides*, **136** ; in dips against ticks, **16.**
Sodium Chloride, in water, effect of, on oviposition by mosquitos, **61** ; tolerance of Anopheline larvae for, **115, 117.**
Sodium Tripolyphosphate, with rotenone in wash against *Hypoderma*, **102.**
sogdianus, *Anopheles marteri.*

Solenopotes capillatus (on cattle), in Australia, **180** ; effect of clipping on, in Wisconsin, **104.**
sollicitans, Aëdes.
Solomon Islands, *Haematopinus quadripertusus* on cattle in, **180.**
Somaliland, British, ticks and relapsing fever in, **97, 98** ; infectivity to lice of strain of *Spirochaeta duttoni* from, **97.**
sonrai, Ornithodoros erraticus.
Spain, *Ornithodoros erraticus* and relapsing fever in, **193.**
Sparrows, *Plasmodium praecox* in, in U.S.A., **89** ; experiments with Anophelines and *P. praecox* from, **89, 203, 204.**
spegazzinii, Haemagogus.
Sperm Oil, Sulphonated (see Nopco 1216).
Spiders, poisonous to man (see *Latrodectus*).
spinulosa, Polyplax.
Spirochaeta, specificity of relation between *Ornithodoros* spp. and species of, **134.** (See Relapsing Fever.)
Spirochaeta anserina, experimental transmission of, by *Ornithodoros moubata*, **169** ; experiments with *Pediculus humanus* and, **182** ; in fowls, **169.**
Spirochaeta brasiliensis, sp. n., in *Ornithodoros brasiliensis* in Brazil, **134.**
Spirochaeta crocidurae (*merionesi, microti*), distribution of, transmitted by form of *Ornithodoros erraticus*, **9, 193** ; experiments with *Pediculus humanus* and, **182** ; in small mammals, **9, 193** ; man infected with, **182, 193** ; characteristics and synonymy of, **193** ; *S. dipodilli* distinct from, **9.**
Spirochaeta dipodilli, sp. n., *Ornithodoros erraticus* transmitting, in gerbils in Kenya, **9** ; experimental vectors and pathogenicity of, **9.**
Spirochaeta duttoni, strains of, causing relapsing fever in East Africa, **97, 98** ; transmitted by *Ornithodoros moubata*, **97** ; experiments with *O. moubata* and, **95, 96, 97, 98** ; experiments with other ticks and, **97, 98** ; in *Pediculus*, **97** ; experiments with lice and, **97, 182**; question of relation of *Cimex hemipterus* to, **97, 98** ; and rats, **98** ; porcupines not a reservoir of, **9** ; effect of penicillin on, **98** ; other spirochaetes compared with, **9, 193.**
Spirochaeta gallinarum (see *S. anserina*).
Spirochaeta harveyi, sp. n., in monkey in Kenya, **97** ; experiments with, **97** ; *S. dipodilli* distinct from, **9.**
Spirochaeta hermsi, experiments with *Pediculus humanus* and, **182.**
Spirochaeta hispanica, distribution, vector and characters of, **193** ; experiments with ticks and, **193** ; experiments with *Pediculus humanus* and, **182.**
Spirochaeta merionesi (see *S. crocidurae*).
Spirochaeta microti (see *S. crocidurae*).
Spirochaeta normandi, experiments with *Pediculus humanus* and, **182.**
Spirochaeta novyi, experiments with *Pediculus humanus* and, **182.**
Spirochaeta parkeri, experiments with *Pediculus humanus* and, **182.**
Spirochaeta persica, experiments with *Pediculus humanus* and, **182.**
Spirochaeta recurrentis, **182.**
Spirochaeta turicatae, experiments with *Pediculus humanus* and, **182** ; *S. dipodilli* distinct from, **9.**
Spotted Fever, ticks transmitting, in U.S.A., **17, 18** ; differentiation of *Ornithodoros* spp. by experiments with, **134** ; tick-borne diseases of type of, in U.S.S.R., **18, 19, 51.**
Sprays, applied to cattle against pests, **34, 45, 180, 181, 182** ; effects on cattle of prolonged treatment with DDT in, **195** ; methods of treating sheep with, against *Melophagus ovinus*, **73** ; against lice on pigs, **110** ; against *Dermacentor variabilis* on roadsides, etc., **77** ; aircraft application of insecticides in, against *Glossina*, **211, 212** ; equipment for applying, **31, 149.** (See Atomised Sprays.)
squamipleuris, Phlebotomus.
Stable Fly (see *Stomoxys calcitrans*).
Starlings, experiments with Anophelines and malaria of, **204.**
Statistical Tables, for biological research, **213.**
Stegomyia (see *Aëdes*).
stephensi, Anopheles.
stigmalis, Culicoides.
Stomoxys calcitrans, Diazinon against, in Switzerland, **199** ; in U.S.A., **34** ; repellents against, **34.**
stramineus, Menacanthus (*Eomenacanthus*).
streptocerca, Dipetalonema (*Agamofilaria*).
Strings, use of dieldrin-treated, against *Musca domestica*, **175.**
subalpinus, Anopheles maculipennis.
subpictus, Anopheles.
Sudan, Anglo-Egyptian, mosquitos and yellow fever in, **190** ; *Simulium* spp. in, **38-39, 147** ; parasites of *S. damnosum* in, **38, 39** ; Tabanids of, **118** ; *Acanthocheilonema perstans* in, **38** ; *Loa loa* in, **118** ; *Onchocerca volvulus* in, **38,**

39 ; trypanosomiasis of domestic animals in, **118**.
suis, *Haematopinus* ; *Phlebotomus*.
sulcifrons, *Tabanus*.
Sulphenone (see p-Chlorophenyl Phenyl Sulphone).
Sulphonated Sperm Oil (see Nopco 1216).
Sulphoxide (see n-Octyl Sulphoxide of Isosafrole).
Sulphur, in ointment against *Dermatophagoides*, **33** ; uses of insecticides with, against *Melophagus ovinus*, **73** ; dust of, against mite on fowls, **102** ; in mixed dust against cotton pests, **144**.
sundaicus, *Anopheles*.
superpictus, *Anopheles*.
Supona Suspensions, **153**.
Switzerland, insecticide resistance in *Musca domestica* in, **71, 199** ; *Stomoxys calcitrans* in, **199**.
wynnertoni, *Glossina*.
ylviarum, *Fonsecaonyssus* (*Bdellonyssus*, *Leiognathus*).
Syrup, in bait for *Musca domestica*, **171**.
Systox, proportions of isomers of active ingredient in, **174**.

T

tabani, *Telenomus*.
Tabanids, in Canada, **23** ; of Sakhalin, **83** ; of Sudan, **118** ; in U.S.A., **45, 46** ; ecology of, in Voronezh, **18, 67, 68** ; and *Loa loa*, **118** ; cattle killed by, **45** ; and trypanosomiasis of domestic animals, **118** ; egg-parasites of, **68** ; function of crop in water-balance of, **20** ; oiling of pools to destroy, **18**. (See *Chrysopa* spp.).
Tabanus bovinus, breeding places of, in Voronezh, **67**.
Tabanus sulcifrons, bionomics of, in U.S.A., **46**.
Tabanus tropicus, breeding places of, in Voronezh, **67**.
Taeniorhynchus (see *Mansonia*).
taeniorhynchus, *Aëdes*.
Tagetes glandulifera, effectiveness of pyrethrum sprays reduced by oil of, **165**.
talaje, *Ornithodoros*.
Talc, as carrier for dusts, **31, 35**.
Tanganyika Territory, *Glossina* spp. in, **27, 39, 212** ; importance of hybridisation of *Trypanosoma rhodesiense* and *T. brucei* in, **27** ; *Ornithodoros moubata* and relapsing fever in, **97, 130**.
tarsalis, *Culex*.
tartakovskyi, *Ornithodoros*.
Tartar Emetic, resistance to, in strains of *Drosophila*, **158**.
Tassle Foot, *Cnemidocoptes* causing, in canaries, **194**.
TDE (see DDD).
Telenomus tabani, parasitising Tabanid eggs in U.S.S.R., **68**.
Temperature, effects of : on *Chrysops silacea*, **27** ; on fleas in rodent burrows, **150** ; on *Glossina*, **40** ; on mosquitos, **23, 114, 163, 164** ; on blood digestion in mosquitos, **209** ; on development of *Musca domestica*, **199, 200** ; on activity of *Simulium venustum*, **210** ; formulae expressing, on insect development, **13** ; on toxicity of DDT, **138, 140** ; on absorption of DDT by *M. domestica*, **140** ; on action of pyrethrins, **62**. (See Cold and Heat.)
Tenebrio molitor, **69** ; experimentally infected with *Rickettsia* spp., **101, 192**.
TEPP (see Tetraethyl Pyrophosphate).
Terphenyl, Chlorinated (see Aroclor 5460).
tessellatus, *Anopheles*.
Tetra(dimethylamido) Pyrophosphate (see Schradan).
Tetraethyl Pyrophosphate, in baits for flies, **145, 171** ; and BHC, **171**.
Tetra-n-propyl Dithionopyrophosphate, test of, against mosquito larvae, **167**.
Thanite, reactions of strains of Diptera to, **82, 158** ; used in testing action of pyrethrum synergists, **166** ; in sprays, **82, 166** ; aerosols of chlordane or DDT and, **82**.
Theileria parva, experiments with *Rhipicephalus appendiculatus* and, in cattle in Uganda, **20-22**.
Thiocyanate (see Butyl Carbitol Thiocyanate).
Thiocyanoacetate, Isobornyl (see Thanite).
tholozani, *Ornithodoros*.
Thrush, Golden (see *Turdus aurantiacus*).
Tick Paralysis, caused by male of *Dermacentor andersoni*, **45**.
Ticks, of West Africa, **169** ; key to species of, infesting livestock in Australia, **112** ; of Sakhalin, **83** ; and relapsing fever, **9, 18, 50, 51, 130, 133, 134, 185, 186, 193** ; experiments with relapsing-fever spirochaetes and, **95, 97, 98, 133, 134, 193** ; and *Spirochaeta anserina*, **169** ; experiments with *Pediculus humanus* and spirochaetes of, **9, 97, 98, 181, 182** ; and Q fever, **51** ; experiments with Q fever rickettsiae and, **51, 192** ; and spotted fever, **17, 18** ; experiments with spotted fever rickettsiae and, **134** ; and related rickettsial diseases in U.S.S.R., **18, 19, 51** ; causing paralysis in man, **45** ; and

Theileria parva in cattle, **20-22** ; rate of blood digestion in, **210** ; longevity and resistance to starvation of, **22, 185, 186** ; parthenogenesis in, **67, 83** ; effect of pasture improvement and ploughing on, **66, 67** ; arsenic resistance in, **180** ; BHC against, **46, 47, 130, 156, 195** ; DDT against, **77, 156, 195** ; other measures and experiments against, **16, 20, 35, 46, 47, 69, 156, 180, 198, 199, 203** ; classification of, **20, 22, 134, 193** ; books on, **22, 169.** (See *Argas*, *Ornithodoros* and *Rhipicephalus*).
TIFA, **52.**
togoi, Aëdes.
Torsalo Fly (see *Dermatobia hominis*).
Toxaphene, not protecting sheep from blowflies, **196** ; test of, against blowfly larvae, **36** ; unsatisfactory against *Culicoides* larvae, **136** ; against *Dermatobia hominis*, **34, 35, 36, 182, 197** ; ineffective in wash against *Hypoderma*, **102** ; against mosquitos, **31, 154, 156, 178** ; effect of, on oviposition by *Aëdes sollicitans*, **105** ; against mosquito larvae, **48** ; acquired resistance to, in mosquito larvae, **48** ; against *Musca domestica*, **44, 107, 137, 156** ; reactions of strains of *M. domestica* to, **82, 122, 123, 124, 137** ; against larvae of *M. domestica*, **35, 36** ; effect of inbreeding and sex on susceptibility of *Drosophila* to, **140, 141** ; toxicity of, to fleas, **87, 156, 157** ; toxicity of, to strains of *Pediculus humanus*, **106, 156, 157, 159** ; against ticks, **35, 46, 156, 180** ; not effective against mites on fowls, **47, 102** ; comparison of toxicity to various arthropods of other insecticides and, **156, 157, 178** ; solutions of, **36, 107, 140** ; emulsified solutions of, **34, 180, 182, 197** ; specifications for emulsion concentrates of, **31** ; in wettable-powder suspensions, **182** ; in acetone-water suspensions, **48** ; in dusts, **87, 102, 105, 106** ; in ointment, **35** ; in sprays, **34, 46, 47, 107, 180, 182, 196, 197** ; surface deposits of, **46, 47, 82, 105, 137, 140, 154, 156, 157, 159** ; vapours of, **44** ; internal treatment of animals with, **36** ; chicks killed by, **102** ; and BHC, **182** ; chemical definition of, **3.**
Toxorhynchites brevipalpis, introduced into Hawaii against *Aëdes albopictus*, **77, 78** ; methods of transporting and rearing, **78.**
Traps, for flies, **44** ; for mosquitos, **56** ; for mosquito larvae, **78, 79, 80.**
Tree Squirrels (see *Callosciurus*).
Tree-holes, mosquitos breeding in, **78, 79, 80, 94, 103, 167, 168.**
triangularis, Hydrous.
Triatoma, adhesive tape as barrier against, **85.**
Triatoma infestans, experiments with *Rickettsia burneti* and, **192** ; rearing of, **84, 85.**
Triatomines, methods of rearing and feeding, **84, 85.**
Tribolium confusum, use of, for testing insecticide deposits, **138.**
1,1,1-Trichloro-2,2-di(p-chlorophenyl)-ethane (see DDT) ; analogues of (see DDT Analogues).
Trichogramma evanescens, parasitising Tabanid eggs in U.S.S.R., **68.**
Trichoptera, as pests on Niagara River, **52** ; uses of DDT against, **52** ; toxicity of Pyrolan to larvae of, **69.**
Trimethylnaphthalene, as solvent for DDT, **41.**
Trinidad, *Anopheles* spp. in, **16, 118, 203, 211.**
trinidadensis, Phlebotomus.
triseriatus, Aëdes.
tritaeniorhynchus, Culex.
Triton X-100, as wetting agent for solution containing radioactive phosphorus, **108.**
Trombicula, ecology of, transmitting tsutsugamushi disease, **5-7, 193, 194** ; influence of humidity on, **5, 6, 7.**
Trombicula akamushi, in Japan, **194** ; in Malaya, **5, 6, 7** ; and tsutsugamushi disease, **5, 6, 7, 193, 194** ; list and discussion of hosts of, **193, 194** ; bionomics and ecology of, **193, 194** ; *T. deliensis* possibly conspecific with, **6, 193.**
Trombicula deliensis, in Bengal, **4, 5** ; in Malaya, **5, 6, 7** ; and tsutsugamushi disease, **4, 5, 6, 7, 193** ; experiments with tsutsugamushi disease and, **4** ; on rats, **4, 5, 7** ; on shrews, **5** ; list and discussion of hosts of, **193** ; bionomics and ecology of, **6, 7, 193** ; rearing of, **4, 7** ; possibly conspecific with *T. akamushi*, **6, 193.**
Trombiculids, of Asia and Australasia, **212** ; relation of, to tsutsugamushi disease, **4-7, 31, 50, 193-194** ; causing dermatitis in man, **50** ; on domestic animals and poultry, **50** ; on wild birds, **6, 193** ; on rodents, **4, 5, 6, 7, 31, 199** ; on shrews, **5** ; repellents against, **203** ; methods of collecting, **5** ; rearing of, **4, 7** ; monograph on, **50** ; classification of, **50, 212.**
tropica, Leishmania.

Tropical Rat Mite (see *Bdellonyssus bacoti*).
tropicus, Tabanus.
Trypanosoma, production and transmissibility by *Glossina* of hybrids of polymorphic, **26, 27.**
Trypanosoma brucei, in Tanganyika, **27** ; transmissibility and infectivity of hybrids of other trypanosomes and, **26, 27.**
Trypanosoma cruzi, device for feeding Triatomines infected with, **85.**
Trypanosoma evansi, relation of Tabanids to, in camels in Sudan, **118.**
Trypanosoma gambiense, causing sleeping sickness in Liberia, **53** ; transmitted by *Glossina palpalis*, **53** ; transmissibility and infectivity of hybrids of other trypanosomes and, **26, 27.**
Trypanosoma rhodesiense, in Tanganyika, **27** ; transmissibility and infectivity of hybrids of other trypanosomes and, **26, 27.**
Trypanosomiasis, relation of Tabanids to, in domestic animals in Sudan, **118.** (See *Trypanosoma* spp.)
Tsutsugamushi Disease, in Burma, **6** ; in India, **4, 5, 6, 7** ; in Malaya, **5, 6, 7, 31** ; relation of Trombiculids to, **4-7, 31, 50, 193, 194** ; in rats, **4, 5, 31, 194** ; list and discussion of mammals infected with, **193, 194.**
tsutsugamushi, Rickettsia (see *R. orientalis*).
Tuamotu Islands, new mosquito recorded as *Aëdes pseudoscutellaris* in, **162.**
tuberculatus, Haematopinus.
tuberosum, Simulium.
Tularaemia, in U.S.S.R., **183, 184, 185** ; in rodents, **184, 185** ; natural and experimental relation of mites to, **183, 184, 185, 200.**
Tunga penetrans, nematode in, in Belgian Congo, **99.**
Tunisia, *Ornithodoros erraticus* and relapsing fever in, **193.**
turanicum, Hyalomma marginatum.
Turdus aurantiacus, Cnemidocoptes jamaicensis on, in Jamaica, **195.**
turicata, Ornithodoros.
turicatae, Spirochaeta (*Borrelia*).
Turpentines, Chlorinated, in sprays against *Musca domestica*, **107** ; preparations containing, against parasites of domestic animals, **110.**
Tween 20, hydrolysed by lipase, **62.**
Typhus (endemic or murine), relation of rat fleas to, in U.S.A., **32, 132, 133** ; survival and infectivity of rickettsiae of, in faeces of *Xenopsylla cheopis*, **132** ; low incidence of, in mice, **66** ; epidemic (see *Rickettsia prowazekii*).
typicus, Anopheles maculipennis.

U

Uganda, *Glossina palpalis* in, **211** ; relation of mosquitos and monkeys to yellow fever in, **10, 24, 25, 93, 94, 161** ; *Simulium* spp. in, **63, 111** ; *Ornithodoros moubata* and relapsing fever in, **97** ; *Rhipicephalus appendiculatus* and East Coast fever of cattle in, **20-22.**
undecimpunctata, Diabrotica.
Undecylenic Acid, treatment of clothing with, as repellent against mosquitos, **203.**
unicornutum, Simulium.
uniformis, Mansonia (*Mansonioides, Taeniorhynchus*).
Union of Soviet Socialist Republics, *Calliphora* spp. and their possible relation to disease in, **82, 83** ; *Musca domestica* in, **199** ; *Phlebotomus* spp. in, **19, 184** ; *Leishmania tropica* in, **184** ; Tabanids in, **18, 67, 68** ; egg-parasites of Tabanids in, **68** ; ticks in, **18, 19, 20, 51, 66, 67, 84, 185, 186** ; tick-borne rickettsial diseases in, **18, 19, 51** ; rodent mites and tularaemia in, **183, 184, 185** ; parasites of domestic animals in, **66, 67, 82, 84, 110, 111, 183.** (See Sakhalin.)
United States of America, blowflies in, **142, 143, 172** ; *Culicoides* spp. in, **136, 137** ; identity and relation to conjunctivitis of *Hippelates* spp. in, **40, 87, 88** ; mosquitos in, **15, 43, 47, 48, 49, 54, 55, 56, 60, 65, 66, 72, 73, 80, 88, 89, 90, 106, 127, 131, 144, 148, 151, 152, 166, 167, 204** ; (California), mosquitos of, **168** ; Mermithids in mosquito larvae in, **60** ; insecticide resistance in mosquitos or mosquito larvae in, **47, 48, 72, 73, 152, 166** ; encephalitis viruses in man and horses in, **65, 66, 127** ; malaria in, **90** ; infectivity to Anophelines of local parasites of avian malaria in, **89** ; *Musca domestica* in, **42, 44, 47, 74, 75, 135, 136, 137, 145, 171, 174, 175, 178** ; relation of *M. domestica* to diarrhoeal disease in, **126** ; insecticide resistance in strains of *M. domestica* in, **74, 75, 76, 136, 137, 145, 171, 174, 175, 178** ; *Stomoxys calcitrans* in, **34** ; Tabanids in, **45, 46** ; cockroaches in, **42, 107, 179** ; insecticide-resistant strain of *Blattella*

germanica in, **179** ; fleas on rodents in, **31, 32, 64, 132, 133, 150, 171** ; other ectoparasites of rats in, **32** ; plague in, **64, 132, 133, 171** ; typhus in, **32, 132, 133** ; pest Trichoptera in, **52** ; *Dermanyssus gallinae* attacking man in, **109** ; ticks in, **17, 18, 46, 51, 77, 133, 134** ; Q fever in, **51** ; relapsing fever in, **133, 134** ; Rocky Mountain spotted fever in, **17, 18** ; insect pests of cattle in, **45, 101, 104** ; parasites of sheep in, **50, 73, 139** ; parasites of fowls in, **46, 102** ; survey of pests and diseases of livestock in, **197** ; pests of rice in, **43** ; book on pest control in, **77**.
uralensis, *Calliphora*.
Uranotaenia sapphirina, breeding places of, in U.S.A., **49**.
Uruguay, BHC-resistance in strain of *Musca domestica* from, **122**.

V

vagus, *Anopheles*.
Valone (see 2-Isovaleryl-1,3-indandione).
vanhoofi, *Anopheles*.
Vaporisers, application of insecticides from, **75, 76**.
variabilis, *Dermacentor*.
variegatum, *Simulium*.
Velsicol NR-70, as solvent for DDT, **55**.
Venezuela, new Anopheline in, **32**.
venustum, *Simulium*.
verrucosus, *Ornithodoros*.
Veterinary Entomology, book on, **112** ; yearbook concerned with, **197**.
Veterinary Zoology, index-catalogue of, **32**.
vexans, *Aëdes*.
villelai, *Phlebotomus*.
vinsoni, *Aëdes* (*Stegomyia*).
violaceum, *Simulium alcocki* (see *S. impukane*).
Virgin Islands, British, eradication of *Boophilus annulatus* in, **16**.
Viruses, book on, infecting man, **113**.
vishnui, *Culex*.
vittatus, *Aëdes*.
vituli, *Linognathus*.
vivax, *Plasmodium*.
volvulus, *Onchocerca*.
Vorticella microstoma, destroying larvae of *Anopheles quadrimaculatus*, **90** ; other mosquito larvae not infected by, **90**.
Vultures, *Argas persicus* associated with, in Pakistan, **210**.

W

Warble-flies (see *Hypoderma*).
Warfarin, not affecting fleas on rats, **32**.
Wetting Agents, studies on reaction of cationic, with sheep fleece, **129**.
wheeleri, *Ornithodoros* (see *O. parkeri*).
Wind, effect of, on mosquitos, **23**.
Wind Tunnel, in apparatus for testing atomised sprays, **142**.
Wood Rat (see *Neotoma*).
Wuchereria bancrofti, in West Africa, **53, 98** ; in China and Hong Kong, **94, 117** ; risk of introduction of, into Guam, **189** ; in Okinawa, **188** ; in Polynesia, **162** ; Anopheline vectors of, **53, 94, 117** ; relation of other mosquitos to nocturnal form of, **188, 189** ; *Aëdes polynesiensis* transmitting non-periodic form of, **162** ; doubtful relation of *A. pseudoscutellaris* to, **162**.
Wuchereria malayi, in Borneo, China and Malaya, **118** ; natural and experimental infection of Anophelines with, **118**.

X

Xenodiagnosis, of *Dipetalonema streptocerca*, **99**.
Xenopsylla cheopis, on rats in U.S.A., **31, 32, 64, 132, 133** ; comparison of mice and rats as hosts for, **66** ; and plague, **132** ; experiments with plague and, **64, 85** ; and murine typhus, **132** ; survival and infectivity of typhus rickettsiae in faeces of, **132** ; experiments with *Rickettsia burneti* and, **192** ; blood digestion in, **85** ; repellent against, **203** ; comparison of toxicity of insecticides to, **87, 156, 157** ; experimentally acquired resistance to DDT in, **157** ; not affected by warfarin, **32**.
Xylene, emulsified solutions of insecticides in, **43, 54, 75, 150** ; method of applying sprays containing, from helicopters, **141**.

Y

Yak, *Hypoderma lineatum* in, in Pamirs, **82**.
Yeast, in medium for rearing *Musca domestica*, **81**.
Yellow Fever, in Bechuanaland, **24** ; in Brazil, **59** ; in Ecuador, **170, 171** ; in Panama, **25, 26, 78, 80** ; in N. Rhodesia, **24, 167** ; in Sudan, **190** ;

in Uganda, **10, 24, 25, 93, 94, 146, 147, 161** ; relation of mosquitos to, **10, 24, 25, 26, 59, 80, 93, 94, 147, 161, 167, 170, 171, 190** ; experiments with mosquitos and, **24, 25, 59, 60** ; virus of, in refrigerated mosquitos, **24** ; relation of, to monkeys, **10, 24, 25, 59, 80, 93, 94, 146, 147, 171** ; in *Potamochoerus porcus*, **93** ; problem of dry season persistence of, in forests, **24, 25, 26, 59, 80, 93, 94, 147, 167.**
yucatenensis, Phlebotomus.

Yugoslavia, Anophelines in, **163** ; *Simulium columbaczense* in, **112** ; *Ornithodoros lahorensis* on sheep in, **18** ; tick-borne relapsing fever not occurring in, **18.**

Z

Zieria smithii, essential oil from, as synergist for pyrethrum, **165.**

Printed in Great Britain under the authority of HER MAJESTY'S STATIONERY OFFICE
by The Eastern Press, Ltd., London and Reading.

(1879) Wt. P8522/3896 11/55 E.P. Ltd. Gp. 566.